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BREAKFAST FOODS.

THEIR CHEMICAL COMPOSITION, DIGESTIBILITY, AND COST.

By R. Harcourt, Professor of Chemistry,
and H. L. Fulmer, Demonstrator in Chemistry.

INTRODUCTION.

The points specially studied in the present investigation into the nutritive value of breakfast foods are as follows:

1. The chemical composition.
2. The influence of the thoroughness of cooking on the solubility of the organic matter of the raw foods.
3. The digestibility of the organic matter of the cooked and malted foods commonly sold as ready-to-serve, and the extent to which the starch of these foods has been changed to dextrin and maltose.
4. The digestibility of different kinds of breakfast foods, and the influence of short and long cooking on the digestibility of the nutrients of oat and wheat meals.
5. The economic value of the various foods, based on the cost and on the determined composition and digestibility.

The Importance of Cereal Grains in our Diet.

The cereal grains are prepared for human consumption in a great variety of ways, and form a very important part of our diet. This is doubtless due to the fact that they are grown in almost all parts of the world; that they are cheap foods; that, when properly prepared, they are comparatively easily and completely digested; and that they contain all the constituents required to nourish the body. Moreover, if the findings of the Chittedon School be proven to be correct, they are destined to be even more important, for most of the cereal grains contain abundance of proteids to supply all that these authorities claim is needed to keep the human system in a healthy, vigorous condition.

Some idea of the immense quantities of these foods consumed annually may be conceived when it is pointed out that the world's yearly crop of wheat alone amounts to several billions of bushels, and all or nearly all of this is used as human food. Furthermore, it is estimated that Great Britain uses six bushels of wheat per capita per year; and an American authority has stated that "Vegetable foods, including flour, breakfast foods, and other cereal products, furnish 55 per cent. of the total food, 39 per cent. of the protein, 8 per cent. of the fat, and 95 per cent. of the carbohydrates of the diet of the ordinary family."* The same authority states that oats, rice, and wheat breakfast foods together furnish about 2 per cent. of the total food, and protein, 1 per cent. of the total fat, and 4 per cent. of the carbohydrates of the ordinary mixed diet. These figures may not appear high, but when we consider the large quantities of food consumed by a family in a year, they represent an immense amount and form a sufficiently important part of our ordinary diet to warrant their careful study.

OUTLINE OF WORK DONE ELSEWHERE.

A large amount of work has been done in various places on this continent in determining the chemical composition and in estimating the comparative value of breakfast foods, and all, or nearly all, of the numerous brands of these foods on the market have been analyzed. Several of the Agricultural Experiment Stations in the United States, principally Storrs, Maine, and Minnesota Stations, have studied the digestibility of these foods. Other Experiment Stations have investigated the influence of the "predigestion" process on the solubility of the organic matter. As the "predigestion" process commonly practised consists almost entirely of the cooking and malting to which the prepared breakfast foods are submitted, and results in bringing starch into solution, it follows that the thoroughness of the preparation processes may be at least approximately estimated by determining the amount of material soluble in water. This knowledge has been utilized by several investigators, particularly at the Wyoming† and Michigan‡ Stations and the Inland Revenue Laboratory, Canada.§ The two latter stations have also made a careful study of the nature of the materials rendered soluble.

The completeness of the digestion of a food is determined by finding out the amount of material absorbed as in the ordinary digestion experiments. Such results, however, give no indication of the ease or rapidity of digestion. Snyder¶ and Gudeman** have investigated the rate of solution or digestion effected by malt, saliva, and pancreatin on breakfast foods cooked for different lengths of time.

THE NATURE OF BREAKFAST FOODS ON THE MARKET.

The origin of the present numerous varieties of breakfast foods may be traced back to the "porridge" made by simply boiling coarsely ground wheat or oats. These materials, while fairly satisfactory to persons of robust health, doing outdoor labor, were often found to so irritate the intestines as to cause increased peristaltic action. This may be an advantage to persons doing sedentary work, but it may be a positive injury to others. With the development of machinery capable of removing the coarse branny parts of the grain, this fault has been largely overcome. More recently there has been a demand for more tasty food of a nature that may be quickly prepared for the table, and a great variety of breakfast cereals of the ready-to-serve type have been placed on the market. These products are, in general, attractive and palatable, and afford a pleasing variety in the diet; and because of special treatment in the process of manufacture, the amount of labor entailed in their preparation for the table is materially reduced. This is doubtless one reason why they have become so popular; but, on the other hand, no class of foods has been so extensively advertised; and such an endless variety of wonderful virtues have been claimed for them that people were led out of curiosity to try them. Some of the breakfast foods are stated to contain several times as much nourishment as the same weight of beef; others are lauded as especially valuable as brain food, or nerve tonics, and very many are claimed to be particularly well suited for persons of weak digestion. There may be some truth in the last statement, but it is evident that many of the claims are utterly groundless. Yet these very fanciful statements have served the purpose of attracting attention, and have, without a doubt, increased the sales of these foods.

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*U. S. Department of Agriculture, Farmers' Bulletin No. 249.

†Wyoming Station Bulletin No. 33.

‡Michigan Agricultural College Experiment Station Bulletin 211.

§Laboratory of the Inland Revenue Department Bulletins Nos. 84, 127, and 132.

¶Minnesota Experiment Station Bulletin No. 74, p. 153.

**Journal American Chemical Society, Vol. 26, p. 321.

The grains commonly used in preparing the breakfast foods in this country are oats, wheat, and corn, and, to some extent, barley and rice. The foods prepared from these may be roughly divided into four classes: (first) the uncooked, (second) the partially cooked, (third) the cooked, and (fourth) the malted and cooked foods.

First. The Uncooked. In the first class we have the granulated [illegible] f oatmeal, the wheat farinas, cornmeal, and rice. The oatmeals [illegible] three grades. The best grade is that known as granulated or pin [illegible] In preparing it the kiln-dried and hulled grain is cut with cutters [illegible] the fine meal, or low grade materials, taken from it. The second grade, known as the standard or mid-cut, is prepared by a gradual reduction of the oat kernels by cutters and grinders and more of the germ of the grain is left in the food. What is called coarse cut, or the third grade, is the whole meal prepared without gradual reduction. In every case the grain is kiln-dried. This makes the grain more brittle, and gives it the desired flavor.

The wheat farinas are sold under a great variety of names, as Cream of Wheat, Meat of Wheat, Wheat Crystals, etc. They are usually prepared from the hard granulated particles of the wheat got from the first and second breaks in the manufacture of flour—the part of the wheat from which the patent flour is made. As the soft winter wheats tend to break down too fine, the hard spring wheats are ordinarily used in the preparation of this class of breakfast foods. Frequently they are "fired" as a last step in their manufacture, to increase the flavor and improve the keeping quality.

Corn bread of various kinds and corn mush are used quite extensively throughout this Province; although in the latter form it does not appear to be so popular as it was formerly. The germ of the corn is relatively large and rich in fat, and flattens out in the grinding, and, therefore, is readily removed when the meal is bolted. As the germ is taken out of most of the finer grades, the corn meal on the market usually contains no more fat than wheat meals. The removal of the germ improves the keeping quality of the corn meal, because the fat tends to become rancid.

Second. The Partially Cooked. These comprise the rolled oats and flaked grains. In preparing the rolled oats, the grain is kiln-dried, either by direct heat or by steam under pressure, hulled, steamed, and rolled. The preliminary treatment of cleaning, kiln-drying, and hulling, is practically the same whether the oats are made into granulated or the rolled forms. The flaked oats are prepared very much in the same way as the rolled oats, but the ends of the grains are broken off and are placed in a lower grade of the meal. A certain amount of fine white dust is also separated and sold as a by-product. Possibly only about 35 to 50 per cent. of the whole grain remains as the flaked product.

Nearly all the grains, including rice, peas, and beans, can now be procured in flaked form. Recently a new form of barley breakfast food has appeared on the market. It differs from the ordinary flaked barley in that in the preparation the grain is first sprouted and then dried, steamed, and rolled. Certain definite changes take place during the sprouting which should render the product more easily digested. As all the rolled and flaked grains, unless roasted or parched after flaking, are only partially cooked, they require thorough cooking before serving.

Third. The Cooked. The class of foods which would naturally fall under our third class are the Shredded Wheat Biscuit, Toasted Corn Flakes, Puffed Wheat Berries, etc. The Shredded Wheat Biscuits are made by softening the wheat, drawing it out into shreds and piling these upon one another until high enough for the desired purpose and then cooked by dry heat. In some cases, as with Toasted Corn Flakes, the raw grain is flaked and then cooked by parching or toasting, or again the raw grains are moistened with water or other liquid, then cooked by roasting, and finally, crushed. Nearly all of these toasted or parched preparations, either shredded or flaked, are sufficiently cooked to be eaten without further cooking.

Fourth. Malted and Cooked. The fourth class of breakfast foods includes those which are both cooked and malted. The cereal grains are rich in starch, which, because of the hard, impervious nature of the walls of the granules of starch, is practically indigestible in the raw state. Cooking ruptures these cell walls and the contents are then comparatively readily acted upon by the digestive juices. The object of treating these starchy foods with malt is to still further reduce the labor of digestion. Malt contains an enzyme called diastase, which has the power of rapidly liquefying the starch after the cell walls are ruptured and of then converting it into dextrin and maltose. The latter substance is a sugar and the former is a somewhat similar compound found in large quantities in the crust of bread and in toast where it has been formed by the action of the high heat to which bread has been submitted and to which the sweetness of these materials is usually attributed. Both of these compounds are very soluble and several steps nearer the completion of the digestive process. Naturally the amount of starch changed into these soluble compounds will depend upon the thoroughness with which the malting process has been carried out. Some investigations we have made on this point indicate that the material rendered soluble varies from 17 per cent. to over 44 per cent. of the dry matter of the food.

It is extremely doubtful if the treatment of cereals with malt materially increases their nutritive value. Persons with weak digestion may find them helpful, but it is hard to understand how this treatment will increase the value of the food to such an extent as is sometimes claimed in advertising matter. They may be more easily digested, but digestion experiments show that they are no more fully digested and absorbed than are the older forms of breakfast foods when properly cooked.

This last class of foods is practically always sold in air-tight paper and cardboard packages, which serve to exclude the dust and dirt that sometimes get into the bin or barrel in which the goods sold in bulk are kept. The neat appearance of these packages, and the appetizing nature of the goods, together with the extensive advertising they have received, have forced the manufacturers of other lines of breakfast foods to be more careful of the quality of their products and to pay more attention to the condition in which they are put upon the market. This has resulted in improvements being made in the machinery for cleaning grain and, in some instances, to greater cleanliness around the mill. Altogether we are safe in concluding that the breakfast foods offered for sale to-day are more carefully prepared and handled than they were in former years.

COMPOSITION OF BREAKFAST FOODS.

To intelligently estimate the nutritive value of any of these foods, several factors must be considered. The most important of these are, the chemical composition, the digestibility, the palatability, and the cost.

In the present investigation, the composition of the foods was ascertained by analyzing samples collected partly from the manufacturer and partly from the retail dealer. The analyses were made according to the methods proposed by the Association of Official Agricultural Chemists, and the results are recorded in Table No. 1.

Before we present the results of the analyses, however, let us review the meaning of the terms used by chemists to designate the various components of a food.

Moisture. Every one of the foods under discussion, no matter how dry it may appear, contains some water which can be driven out by heat. A high water content is not desirable, because it not only diminishes the percentage of actual food material, but it also tends to cause the food to mould or turn sour. Water has certain physiological functions to perform in the body, but it may be supplied from so many sources that it has no particular value as a food.

Protein is the name commonly given to a class of substances which furnish the materials for the formation of bone, flesh, blood, etc. This constituent is absolutely essential in the food of animals; for, without it, no animal can grow or even subsist. Moreover, the animal is totally unable to create protein; that is a function of plant life. The animal can simply appropriate and transform the protein of plants into the particular proteids of the body. Protein, when oxidized or burned in the body, will produce heat, and if eaten in excess of that required for other purposes, may form fat. Altogether protein is one of the most important constituents of a food, and the one which is the most expensive. Hence we naturally like to find a food rich in this substance.

Fat, or ether extract, is that part of the food which may be extracted from the water-free material by ether, benzine, gasoline, etc. It is of value for the formation of fat in the body and for the production of energy and heat. For this latter purpose it has more than twice the value of protein and carbohydrates. Fat may, therefore, be looked upon as a concentrated heat producer.

The Soluble Carbohydrates, or nitrogen-free extract, consist mainly of starches, sugars, and closely allied compounds. In the cereal breakfast foods these soluble carbohydrates form about two-thirds of the whole material. Their particular function in the body is to form fat, or, when oxidized, to produce heat and energy. They are frequently called the energy or heat producers.

Crude Fibre is the term applied to a group of substances which form the woody or straw-like frame-work of plants. It is so indigestible that it has almost no food value, and, further, it frequently renders the rest of the food less digestible by protecting it from the action of the digestive fluids. Therefore, a large amount of it in a food is not desired. Yet, it is undoubtedly physiologically useful in giving the needed bulk to the food.

Ash is the inorganic or mineral part of foods. It is of great importance in the food of the young, as it furnishes the phosphates, chlorides, and other salts of calcium, magnesium, sodium, potassium, iron, etc., which are needed in building up [illegible] and the tissues of the body.

Heat of Combustion. The various nutrients above referred to when supplied in the food enable the body to grow and to repair its tissues as they are worn out in the necessary exercise of the body functions. They also supply the body with the energy needed for doing work both internal and external, and furnish the heat to keep the body warm. All the nutrients, except the ash, may be oxidized or burned in the body, and are, therefore, sources of energy. Consequently, the total energy value of a food may be determined by measuring the amount of heat given off when a definite weight of the food is burned. This energy value is conveniently stated in terms of heat, the Calorie,* or unit of heat, being used for this purpose. The number of Calories of heat a gram of each food is capable of producing, if fully burned, is given in the last column of Table No. 1. As it was not convenient for us to determine the actual fuel values, the figures were obtained by calculating them on the basis proposed by Dr. H. W. Wiley.†

It is very difficult to form a correct comparative estimate of the nutritive value of the breakfast foods from the percentage composition alone. For this reason we sometimes value the foods on the basis of their ability to produce heat, and, if we assume that they are fed in a properly arranged diet, the fuel values indicate fairly well the comparative nutritive values of the total food.

With the foregoing facts in mind regarding the value of the different nutrients, we now turn to the table of composition:

TABLE No. 1—PERCENTAGE COMPOSITION OF SOME BREAKFAST FOODS.

Sample Number.	Foods and Manufacturers.	Water.	Crude Protein.	Crude Fat.	Nitrogen Free Extract.	Crude Fibre.	Ash.	Heat of Combustion per gram Calories.
	OAT PRODUCTS							
	Granulated Oatmeal from:							
10	D. R. Ross, Embro	7.31	13.31	6.30	69.16	2.42	1.50	4.306
14	Martin Bros., Mount Forest	7.51	12.43	6.31	70.29	94	1.52	4.282
40	Martin Bros., Mount Forest	7.56	12.77	6.31	70.22	1.49	1.65	4.277
18	Am. Cereal Co., Peterboro	9.16	12.26	7.26	68.53	1.32	1.47	4.262
27	Flavelle Milling Co., Lindsay	7.68	12.62	6.29	70.68	1.36	1.37	4.283
	Standard Oatmeal from:							
35	Martin Bros., Mount Forest	7.35	13.17	7.53	69.19	1.04	1.72	4.412
39	Martin Bros, Mount Forest	7.84	13.44	6.95	68.36	1.56	1.85	4.306
24	Am. Cereal Co., Peterboro	8.53	13.30	6.49	68.61	1.63	1.41	4.268
20	D. & S. Am. Cereal Co., Peterboro	9.33	12.80	7.40	67.98	1.45	1.40	4.257
13	D. R. Ross, Embro	7.95	15.28	5.77	66.69	2.01	2.30	4.254
28	Flavelle Milling Co., Lindsay	6.71	12.21	7.61	70.62	..16	1.68	4.371

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*A Calorie represents the amount of heat required to raise the temperature of 1,000 grams of water 1° C.

†Bulletin No. 13, part 9, Bureau of Chemistry, Department of Agriculture, U.S.A.

TABLE No. 1: PERCENTAGE COMPOSITION OF SOME BREAKFAST FOODS.—*Continued.*

Sample Number.	Foods and Manufacturers.	Water.	Crude Protein.	Crude Fat.	Nitrogen Free Extract.	Crude Fibre.	Ash.	Heat of Combustion per gram Calories.
	Coarse Cut Oatmeal from;							
26	Martin Bros., Mount Forest...	8.15	12.77	6.01	69.65	1.80	1.62	4.242
	Rolled Oatmeal from:							
2	Galt Milling Co., Galt...	9.42	12.45	7.30	68.10	1.06	1.67	4.249
3	W. Thomson & Son, London..	9.59	12.28	6.52	68.83	1.18	1.80	4.141
25	W. Thomson & Son, London..	8.68	12.29	5.99	70.16	1.39	1.49	4.216
4	Tillson Co., Tillsonburg......	8.04	14.39	7.24	67.37	1.08	1.88	4.746
51	“ “	9.47	11.29	6.41	69.82	1.35	1.66	4.180
52	“ “	9.00	11.81	5.96	70.20	1.39	1.64	4.187
53	“ “	9.36	11.84	5.68	69.94	1.30	1.88	4.148
54	“ “	8.41	12.23	6.69	69.70	1.35	1.62	4.257
44	“ “	7.45	12.21	7.27	70.22	1.15	1.70	4.323
7	Woodstock Cereal Co., Woodstock....................	8.50	13.12	4.14	71.72	0.80	1.72	4.221
11	D. R. Ross, Embro..........	9.52	13.11	5.94	68.61	1.30	1.51	4.192
17	P. McIntosh & Son, Toronto..	9.11	11.69	6.82	69.20	1.53	1.65	4.224
23	American Cereal Co., Peterboro	9.70	13.30	6.80	67.23	1.42	1.55	4.232
42	“ “ “	8.12	13.25	7.28	68.45	1.12	1.78	4.321
55	“ “ “	8.71	12.26	7.98	67.92	1.55	1.58	4.401
56	“ “ “	8.56	12.21	7.76	68.51	1.42	1.54	4.309
29	Flavelle Milling Co., Lindsay.	6.20	11.57	7.68	71.96	1.25	1.34	4.396
31	Martin Bros., Mount Forest...	7.93	12.09	7.47	69.72	1.11	1.68	4.312
32	Ground Oatmeal, Galt Milling Co....................	8.60	12.43	6.10	69.30	1.31	2.23	4.196
	WHEAT PRODUCTS.							
1	Wheatine, Milne Bros., Markham	10.90	11.91	2.00	72.33	1.37	1.49	3.910
6	Steven's Breakfast Food, Canada Flour Mills Co., Chatham	11.38	9.18	0.83	77.20	0.58	0.83	3.800
38	Steven's Breakfast Food, Canada Flour Mills Co., Chatham	10.58	9.18	1.10	78.24	0.36	0.54	3.877
8	Farina, Goldie Milling Co., Ayr....................	12.13	9.01	0.61	77.05	0.55	0.65	3.670
45	Farina, Goldie Milling Co., Guelph.................	10.55	9.70	1.36	77.53	0.44	0.42	3.896
36	Wheat Germ, Goldie Milling Co., Guelph............	8.39	10.97	2.79	75.61	1.16	1.08	4.073
33	Wheat Crystals, Hedley, Shaw Milling Co., Toronto.....	9.57	11.53	1.36	76.34	0.44	0.76	3.955
49	Meat of Wheat, Western Cereal Co., Winnipeg.	10.60	9.17	1.40	78.46	......	0.37	3.888
50	Cream of Wheat, Cream of Wheat Co., Minneapolis..	11.04	9.14	0.43	78.93	......	0.46	3.815

TABLE No. 1: PERCENTAGE COMPOSITION OF SOME BREAKFAST FOODS.—*Continued.*

Sample Number.	Foods and Manufacturers.	Water.	Crude Protein.	Crude Fat.	Nitrogen Free Extract.	Crude Fibre.	Ash.	Heat of Combustion per gram Calories.
	Rolled Wheat:							
86	Swiss Food, P. McIntosh & Son	12.10	9.63	0.86	73.65	1.88	1.82	3.745
87	Pettijohn Breakfast Food, American Cereal Co., Chicago	11.66	9.63	0.65	74.54	1.98	1.54	3.766
5	Rolled Wheat, Tillson Co., Tillsonburg..............	10.96	8.16	1.83	75.14	1.71	1.75	3.829
41	Rolled Wheat, Tillson Co., Tillsonburg..............	9.19	9.81	2.27	76.15	1.07	1.51	3.956
22	Rolled Wheat, Robt. Greig Co., Toronto.............	9.86	8.94	1.97	75.19	2.39	1.65	3.893
	BARLEY PRODUCTS.							
16	Cracked Barley, Tillson Co., Tillsonburg..............	9.49	9.23	0.84	77.72	1.34	1.38	3.864
46	Flaked Barley, Tillson Co....	10.18	10.62	1.21	75.62	1.27	1.10	3.892
47	Flaked Barley, Robt. Greig Co., Toronto.............	9.79	8.87	1.24	78.45	0.77	0.88	3.887
21	Flaked Barley, Robt. Greig Co., Toronto.............	12.76	9.34	0.88	75.34	0.98	0.70	3.762
	CORN PRODUCTS.							
30	Corn Meal, Tillson Co., Tillsonburg....................	10.00	7.11	1.88	79.72	0.58	0.71	3.887
37	Corn Meal, Tillson Co., Tillsonburg....................	9.52	6.87	0.65	82.21	0.46	0.29	3.855
83	Corn Meal, Tillson Co., Tillsonburg....................	10.18	5.70	1.22	81.93	0.54	0.43	3.831
19	Rice Flakes, Robt. Greig Co., Toronto	12.29	7.24	0.08	79.49	0.55	0.35	3.716
	READY TO SERVE PRODUCTS.							
9	Orange Meat, Sample 1, Frontenac Cereal Co., Kingston	8.36	8.66	1.12	77.89	1.95	2.02	3.887
59	Orange Meat, Sample 2... ...	7.63	9.19	1.33	79.97	......	1.88	3.945
60	“ “ 3.	10.31	10.81	1.51	75.52	......	1.85	3.875
34	Canada Flakes, Sample 1, Peterboro Cereal Co., Peterboro....................	7.49	9.42	1.65	76.53	2.21	2.70	3.938
61	Canada Flakes, Sample 2.....	8.81	10.81	1.36	75.99	......	1.36	3.880
	“ “ 3.....	9.16	11.06	1.00	76.23	......	2.55	3.871
43	Force, Sample 1, The “Force” Food Co., Buffalo, N.Y...	7.37	9.81	2.13	76.45	1.85	2.40	3.987
63	Force, Sample 2..............	9.93	10.88	1.00	75.62	......	2.57	3 835
64	“ “ 3..............	9.92	9.65	1.40	76.76	......	2.27	3.847

TABLE NO. 1—PERCENTAGE COMPOSITION OF SOME BREAKFAST FOODS.—*Concluded.*

Sample Number.	Foods and Manufacturers.	Water.	Crude Protein.	Crude Fat.	Nitrogen Free Extract.	Crude Fibre.	Ash.	Heat of Combustion per gram Calories.
	READY TO SERVE PRODUCTS-*Con.*							
48	Norka, Norka Food Co., Battle Creek, U.S	7.10	13.57	4.83	69.70	1.84	2.96	4.183
65	Norka, Sample 2.............	7.18	14.88	6.03	69.19	......	2.72	4.276
66	" " 3.............	7.86	14.75	5.78	68.87	......	2.74	4.232
57	Malta Vita, Sample 1, Pure Food Co., Battle Creek...	8.79	8.78	0.92	79.30	......	2.21	3.855
67	Malta Vita, Sample 2.........	7.70	10.88	1.63	77.42	.....	2.37	3.968
68	" " 3.........	8.24	10.06	1.54	78.03	......	2.13	3.937
58	Grape Nuts, Postum Cereal Co., Battle Creek, U.S...	5.68	9.49	0.64	82.50	......	1.69	4.002
69	Grape Nuts, Sample 2........	7.47	12.37	1.50	76.89	......	1.77	4.022
70	" " 3........	8.10	12.63	0.70	76.89	......	1.68	3.963
71	Shredded Wheat, Sample 1, Canadian Shredded Wheat Co., Niagara Falls........	9.54	12.00	1.06	75.76	......	1.64	3.913
72	Shredded Wheat, Sample 2...	9.28	10.81	0.64	75.50	......	1.77	3.874
74	Quaker Wheat Berries, American Cereal Co., Chicago, Sample 1	9.15	11.05	2.00	73.03	3.33	1.44	3.969
75	Quaker Wheat Berries, sample 2	8.99	11.23	2.21	72.67	3.46	1.44	3.989
76	" " 3	8.98	11.51	2.56	72.56	2.96	1.43	4.014
77	" " 4	8.96	12.26	2.58	71.33	3.55	1.32	4.033
78	Toasted Corn Flakes, Battle Creek Health Food Co., London, Ont., Sample 1..	9.85	5.35	2.69	79.57	0.64	1.90	3.855
79	Toasted Corn Flakes, Sample 2	9.81	5.42	1.05	81.97	0.64	1.11	3.805
80	" " " 3	9.75	5.19	1.11	81.32	0.64	1.99	3.800
81	" " " 4	9.65	6.21	1.11	80.24	0.66	2.13	3.787
82	Quaker Puffed Rice, American Cereal Co., Chicago......	10.16	5.20	0.33	83.25	0.70	0.36	3.887
84	Life Chips, Battle Creek Health Food Co., London.......	8.68	6.78	2.11	77.96	1.99	2.48	3.874
85	Gusto, The Hoco Mills Co., Buffalo, N.Y	11.20	7.18	0.24	77.24	1.51	2.63	3.675
88	Granose Flakes, Battle Creek Health Food Co., London	9.96	8.32	0.32	77.30	1.99	2.11	3.772
89	Granose Biscuit, Battle Creek Health Food Co., London	12.31	8.04	0.71	73.65	1.95	3.34	3.640
90	Malt Breakfast Food, The Malted Cereals Co., Burlington, Vt..............	10.05	11.80	0.46	75.37	1.17	1.20	3.875

Properly matured grain of the same species and variety is fairly constant in composition, but different varieties of grain, or the same variety grown in different sections of the country, or in different years, will vary slightly. One of the objects of giving the results of the analysis of the individual samples is to show this variation. It is evident that the method of preparing the various kinds of oatmeals has not materially affected the composition, for there is a general similarity in the percentages of protein, fat, etc., and even in crude fibre, in all forms of these foods. The differences in the composition are most evident in the protein column, and these must be due largely to the differences in the original grain.

With reference to the wheat products, it is obvious that the different names given to the various foods by the manufacturer are not associated with wide differences in chemical composition. When these foods are composed of the granular particles from the first and second breaks in the regular flour milling process, a portion of the bran layers will naturally be excluded, and the resulting product will not contain so much crude fibre and ash as the whole grain. This, it will be noticed, is the case with the farinas, such as Wheat Crystals, Meat of Wheat, and Cream of Wheat. Wheatine and the rolled wheats more nearly resemble the composition of the whole grain.

Judging by the similarity of the composition of the cracked and flaked barley, it is evident that the latter is practically the whole hulled grain.

For reasons previously stated, the germ is removed in preparing the finer grades of cornmeal. Consequently, while the whole corn kernel contains about five per cent. of fat, the cornmeals analyzed have less than two. The comparatively wide variation in the amount of this constituent is probably due to differences in the amount of the germ left in the meal. This food is also characterized by its low crude fibre and high nitrogen free extract content.

The composition of the different samples of the same kind of the ready-to-serve foods is fairly uniform, but, naturally, the foods are subject to the same variations in this respect as the grains from which they are prepared. Thus Norka is an oat product, and, consequently it is richer in both proteids and fat than the preparations made from wheat and corn. The latter substances, as represented by Toasted Corn Flakes, are particularly low in proteids and crude fibre.

To bring out more clearly the differences in composition of the various kinds of foods analyzed, the results have been averaged, and they are given in Table No. 2. For purposes of comparison the composition of a few of the more common foods that occur in our daily diet are also given.

In general, it may be pointed out that the oatmeals and Norka contain the most protein and fat, while all the other foods are richer in carbohydrates. The cornmeals are the lowest in protein and the highest in carbohydrates, and wheat farinas and cornmeal contain the least fibre. The germ of a seed is rich in protein and fat, consequently, we are not surprised to find the wheat germ richer in these constituents than the other wheat products. The malted foods are not richer in the valuable

TABLE No. 2: TABLE OF AVERAGE COMPOSITION.

Product.	No. of samples analysed.	Water.	Crude Protein.	Crude Fat.	Nitrogen free extract.	Crude Fibre.	Ash.	Heat of Combustion per gm. Calorie.
Granulated Oatmeal	5	7.84	12.68	6.49	69.78	1.71	1.50	4.283
Standard Oatmeal	6	7.95	13.37	6.90	68.57	1.48	1.73	4.276
Coarse Cut Oatmeal	1	8.15	12.77	6.01	69.65	1.80	1.62	4.242
Rolled Oatmeal	18	8.60	12.41	6.72	69.36	1.26	1.65	4.253
Wheat Farinas	7	10.84	9.56	1.01	77.54	.47	.58	3.856
Wheat Germ	1	8.39	10.97	2.79	75.61	1.16	1.08	4.073
Rolled Wheat	5	10.79	9.25	1.51	74.94	1.80	1.71	3.832
Flaked Barley	3	10.91	9.61	1.11	76.47	1.01	.89	3.847
Corn Meal	3	9.90	6.56	1.25	81.28	.53	.48	3.857
Malt Breakfast Food	1	10.05	11.80	.46	75.32	1.17	1.20	3.875
Orange Meat	3	8.77	9.55	1.32	76.49	1.95	1.92	3.903
Canada Flakes	3	8.49	10.43	1.34	75.33	2.21	2.20	3.919
Force	3	9.07	10.11	1.51	75.05	1.85	2.41	3.890
Norka	3	7.38	14.40	5.55	68.02	1.84	2.81	4.230
Malta Vita	3	8.24	9.91	1.36	*78.25	......	2.24	3.919
Grape Nuts	3	7.08	11.50	.95	*78.76	......	1.71	3.996
Shredded Wheat	2	9.41	11.41	.85	*76.62	......	1.71	3.894
Quaker Wheat Berries	4	9.02	11.51	2.34	72.39	3.33	1.41	3.991
Toasted Corn Flakes	4	9.77	5.52	1.49	80.79	.65	1.78	3.803
Quaker Puffed Rice	1	10.16	5.20	.33	83.25	.70	.36	3.887
Rice Flakes	1	12.29	7.24	.08	79.49	.55	.35	3.716
Life Chips	1	8.68	6.78	2.11	77.96	1.99	2.48	3.874
Gusto	1	11.20	7.18	.24	77.24	1.51	2.63	3.675
Granose Flakes	1	9.96	8.32	.32	77.30	1.99	2.11	3.772
Granose Biscuits	1	12.31	8.04	.71	73.65	1.95	3.34	3.640
Miscellaneous Foods for Comparison.								
Flakes Peas	1	8.06	23.39	1.74	63.18	.70	2.13	3.716
White Bread†	4	40.06	8.49	1.87	48.73	......	.85	2.673
Entire Wheat Bread†	3	45.41	7.79	2.27	43.47	......	1.06	2.453
Graham Bread†	2	45.00	8.02	2.49	43.00	......	1.49	2.468
Sirloin Steak‡	......	61.9	18.9	18.5	......	......	1.00	2.836
Whole Egg, edible portion‡	......	73.7	18.9	10.5	......	......	1.00	1.767
Cheese, as purchased‡	......	34.2	25.9	33.7	2.4	......	3.80	4.761
Milk§	5,000	87.1	3.2	3.9	5.1	......	.70	.751
Potatoes	81	78.41	2.18	0.1	17.82	.60	.89	.893

* Includes crude fibre.

† U.S. Department of Agriculture, Office of Experiment Stations, Bull, No. 148, p. 14. Averages of analyses of bread made from flour samples Nos. 6133, 6142 and 6155.

‡ U.S. Department of Agriculture, Farmers' Bulletin No. 128, p. 12.

§ "Modern Methods of Testing Milk and Milk Products," Van Slyke, p. 15.

nutrients than the other foods, and, so far as we may judge from their mere chemical composition, are not superior in value. Taking all the facts into consideration, we would naturally be led to conclude that, as the oat products contain the most protein, or muscle-forming material, and the largest percentage of fat, they are the most nutritious foods. It is also evident that these foods are also superior to all others as heat producers.

INFLUENCE OF SPECIAL PROCESS OF MANUFACTURE ON SOLUBILITY OF FOODS.

The composition, as given above, does not show the changes that cooking, parching and malting processes have effected in the ready-to-serve foods, and, as it is because of these changes that so much is claimed for them, we studied this point somewhat fully. The object of treating these foods with malt is to increase the solubility, and, consequently, the ease of digestion of the starch. As previously explained, the diastase of malt converts starch into dextrin and maltose,—water-soluble compounds. Cooking in water, or by dry heat, as in toasting or parching, also tends to break down starch into simpler substances which are soluble in water. If, then, we determine the amount of a food that will dissolve in water, we must, to some extent, measure the efficiency of the malting and cooking processes used in the preparation of that food. In order that we might procure some data on this point, we determined the amount of the total solids soluble in water in some uncooked, partially cooked, cooked, and cooked and malted foods. We also analyzed the water extract to ascertain how far the decomposition process had proceeded.

The methods used in making the extractions and determinations were based on those outlined by A. McGill in Bulletin No. 84, Inland Revenue Department, Ottawa. Briefly, the methods were as follows. 100 grams of the material in its natural condition and 1,000 cc. of distilled water at room temperature were placed in a 2-litre bottle, and fastened on a rotating machine which turned the bottles end over end at the rate of 40 revolutions per minute for 24 hours. Previous experimental work demonstrated that up to this length of time there was a sensible increase in the amount of material brought into solution. The contents of the bottle were then placed in a cup of 300 cc. capacity in a large centrifuge and whirled at the rate of 2,000 revolutions per minute for one hour, or until the insoluble matter was thrown down. After filtering through close paper, to insure a clear solution, the per cent. of solids, dextrin, sugar, and proteids were determined. The dextrin was estimated by evaporating a portion of the clear filtrate nearly to dryness, and afterwards taking up with alcohol, filtering off, drying, and weighing the resulting precipitate. As such a precipitate would not be pure dextrin, it is reported simply as "alcohol precipitate." The sugar was determined in the usual way with Fehling's solution, and, as no effort was made to separate the probable sugars present, it was reported as "cuprous oxide precipitate." Approximately, 1 per cent. of cuprous oxide is equal to

.542 per cent. of dextrose or grape sugar, or .81 per cent. of maltose. As generally carried out, the malting and cooking processes will not decompose starch into compounds simpler than maltose, and if dextrose is present, it may, under ordinary conditions, be looked upon as an added product. The amount of nitrogen was obtained by the Kjeldahl method and multiplied by the factor 5.7 to convert to protein. It is obvious that the results may not indicate the amount of the several constituents present in a soluble form in the food as purchased, but they do show the amount that is brought into solution under a similar method of treatment and may be used for purposes of comparison. The results obtained are embodied in the following table:

TABLE No. 3; PERCENTAGE OF WATER SOLUBLE MATERIALS IN FOODS EXAMINED.

Food.	No. of samples analysed.	Total solids.	Alcohol ppt. (dextrin).	Cuprous oxide ppt. (sugar).	Soluble Proteids.
Uncooked Foods.					
Wheat Farinas	13	6.60	.97	1.18	2.42
Wheat Germ................	2	7.06	2.45	3.03	1.93
Granulated Oatmeals	4	6.55	*	none.	*
Partially Cooked Foods.					
Rolled Oats	19	6.68	2.53	none.	.74
Swiss Food (rolled wheat)....	1	5.95	*	*	*
Cooked Foods.					
Shredded Wheat	7	13.71	8.26	2.03	*
Quaker Wheat Berries	4	27.00	22.58	3.47	2.28
Toasted Corn Flakes..........	4	28.3	19.63	5.77	.32
Quaker Puffed Rice..........	1	41.61	41.82	2.11	1.34
Malted Foods.					
Malt Breakfast Food.........	1	14.77	.66	10.63	.86
Malted and Cooked Foods.					
Orange Meat	2	23.65	†8.66	†7.43	*
Grape Nuts	5	44.20	12.96	21.02	1.73
Malta Vita..................	5	25.45	9.97	8.01	1.38
Canada Flakes	3	28.60	†10.16	†12.53	*
Force	7	17.08	9.16	2.73	*
Life Chips	1	18.92	9.84	2.59	.86
Gusto......................	1	25.14	8.14	2.01	.53
Norka	1	28.17	12.42	10.89	*

* No determination made.
† One result only.

The above figures clearly show that there are wide differences in the solubility of the dry matter and in the quantity of alcohol precipitate (dextrin) and reducing substances (sugars) in the foods examined. The percentage amount of the solids of the farinas, wheat germ, and granulated oatmeals dissolved is about equal, while the partial cooking to which the rolled oats and wheat were incidentally subjected in the process of manufacture, has not been sufficient to materially increase the solubility of these foods. Or, if, as some contend, diastase is present in very small quantities in raw grain, possibly the solubility of the uncooked foods has been influenced by enzymic action.

Among the foods sold as being cooked sufficiently to be ready to serve, it will be observed that there are wide differences in the per cent. of solids soluble in water. This indicates that some were much more thoroughly cooked than others. It is also evident that the cooking has not resulted in the formation of any appreciable amount of sugar. The Malt Breakfast Food, which was malted but not cooked, shows a considerable amount of sugar, showing that the process was continued far enough to cause a large portion of the solids to pass through the dextrin into the sugar. It is, of course, possible, that sugar was added, but no effort was made to ascertain this point. It may be stated, however, that there was evidence that the food was really malted.

Among the malted and cooked foods there are also wide differences in the percentage amount of soluble matter. It must be remembered that the amount of malt used and the length of time it is allowed to act must influence the quantity of the starch rendered soluble and also the amount of sugar formed. Some of these foods do not contain as much soluble matter as the foods that were cooked only. The same foods have no more, or very little more, sugar than the uncooked foods, which would indicate that very little change due to malting had really taken place. Certainly there is very little to show that some of these foods have been any more than cooked, and, it will be shown later, that the cooking, as measured by the solubility of the carbohydrates, has not been as thorough as is commonly practiced in preparing the ordinary farinas and oatmeals for the table. Further, it is apparent that the predigestion has not affected the solubility of the proteids, for the water extract of these malted or "predigested" foods contains no more of these valuable food constituents than that obtained from the cooked foods. This is as expected, for the malting process can affect the carbohydrates only and has no influence on the other constituents of the food.

It is quite conceivable that in the preparation of different lots of the same brand of food, the manufacturer may consciously or unconsciously have allowed the malting process to proceed further with some than with others, or the cooking may have been more thorough. Any such differences in treatment would cause variation in solubility between the different lots or batches, so that one package of a food may not be as soluble or as readily digested as another. In some cases these variations were so wide as to seriously affect the value of the food. The following table, which contains the individual results obtained from some of the foods, is given to show these variations:

TABLE No. 4: PERCENTAGE OF WATER SOLUBLE MATERIAL IN DIFFERENT SAMPLES OF THE SAME BRAND OF FOODS.

Food.	Total Solids.	Alcohol ppt. (dextrin).	Cuprous oxide ppt. (sugar).	Soluble proteids.
Uncooked Foods.				
1. Farina	5.08	1.94	1.11	*
2. Cream of Wheat	4.83	1.95	.88	1.69
3. “ “	5.04	1.80	1.43	1.83
4. Goldie's Farina	5.65	1.76	.90	2.98
5. Steven's Breakfast Food	6.84	1.36	2.12	2.23
6. “ “ “	5.97	1.28	1.44	2.26
Partially Cooked Food.				
1. Tillson's Oatmeal	8.43	2.36	none.	*
2. “ “	7.8	3.03	“	.67
3. “ “	6.7	1.68	“	1.15
4. “ “	8.0	2.99	“	1.21
5. “ “	10.10	4.20	“	.65
6. “ “	6.28	3.16	“	.58
7. “ “	7.04	3.99	“	*
8. “ “	9.09	3.45	“	.86
9. “ “	7.27	4.58	“	.87
1. Quaker Oats	5.42	*	“	*
2. “ “	5.20	.80	“	.76
3. “ “	5.60	.72	“	.67
4. “ “	5.60	.54	“	.67
5. “ “	6.8	1.45	“	.79
6. “ “	5.3	1.16	“	.67
7. “ “	5.89	2.30	“	.60
8. “ “	5.18	1.86	“	.81
Cooked Foods.				
1. Shredded Wheat	8.76	4.11	.26	*
2. “ “	14.33	8.57	2.00	*
3. “ “	14.92	9.64	2.46	*
4. “ “	14.54	9.02	1.77	*
5. “ “	13.96	8.65	2.39	*
6. “ “	14.95	9.03	2.88	*
7. “ “	14.48	8.81	2.76	*
1. Quaker Wheat Berries	28.1	23.52	3.34	2.33
2. “ “	28.5	24.30	3.72	2.39
3. “ “	23.9	19.55	3.51	2.14

TABLE No. 4: PERCENTAGE OF WATER SOLUBLE MATERIAL IN DIFFERENT SAMPLES OF THE SAME BRAND OF FOODS.—*Concluded.*

Food.	Total Solids.	Alcohol ppt. (dextrin).	Cuprous oxide ppt. (sugar).	Soluble proteids.
Cooked Foods.—Con.				
4. Quaker Wheat Berries	27.5	22.96	3.30	2.27
1. Toasted Corn Flakes	28.6	19.86	5.16	.45
2. “ “	28.1	19.25	5.81	.26
3. “ “	28.2	19.82	6.64	.29
4. “ “	28.4	19.60	5.38	.29
Malted and Cooked Foods.				
1. Canada Flakes	26.43	10.16	12.53	*
2. “ “	30.66	*	*	*
3. “ “	30.87	*	*	*
1. Malta Vita	29.01	13.72	9.02	*
2. “	30.81	10.19	13.78	1.20
3. “	25.09	9.35	7.91	1.51
4. “	22.37	7.72	6.76	1.36
5. “	19.97	8.86	2.58	1.44
1. Grape Nuts	41.84	12.67	19.14	1.64
2. “	44.51	13.00	19.90	1.84
3. “	44.83	13.36	22.74	1.76
4. “	43.78	12.80	20.89	1.76
5. “	46.14	12.97	22.41	1.68
1. Force	14.08	5.30	.61	*
2. “	18.08	8.73	1.73	*
3. “	17.40	8.31	2.53	*
4. “	15.34	11.06	2.73	*
5. “	16.59	11.67	3.38	*
6. “	20.34	9.01	2.86	*
7. “	16.70	10 22	4.23	*
1. Orange Meat	20.53	8.66	7.43	*
2. “	26.77	*	*	*

* No determination made.

It is unnecessary to dwell on the results presented in the above table. As might be expected, there is very little variation in the amount and the make-up of the soluble matter in the various forms of farinas examined. There is, however, a noticeable difference in the amount of soluble matter extracted from the Tillson's oatmeal and the Quaker oats. If we are not mistaken, the former are kiln-dried by direct heat, whereas the latter are dried by means of steam. It would possibly be more difficult to control the temperature when the former method is used, and, as the greater the heat to which the oats are submitted, the greater the amount of the starch dextrinized or rendered soluble, it is evident that the Tillson product has been heated slightly higher and that different lots have not been submitted to a uniform temperature.

Among the cooked, and the cooked and malted classes of foods there is sufficient variation in the amount of soluble matter to show that the different lots or batches of the same kind of food are not always prepared in exactly the same manner. It may be that in some lots more malt was used, or the malting period was longer, or that the toasting or parching process to which the foods are generally submitted was more thorough—all of which would cause variation in the percentage amounts of soluble matter.

INFLUENCE OF COOKING ON SOLUBILITY OF FOODS.

In general it may be safely stated that the thorough cooking of cereal foods is quite as important as the proportion of the nutrients which they contain. The chief purposes of cooking are: first, to sterilize the material, so that any undesirable bacteria, if accidentally present may be destroyed; second, to improve flavor—making the food more appetizing and thus increasing its digestibility by stimulating the flow of digestive juices; and third, to so change the structure of the material, especially the carbohydrates, that they may be more readily digested. Possibly the last may be regarded as the most important, because, as previously stated, starch, which forms a very large proportion of these foods, is enclosed in cells, the walls of which are composed of crude fibre. This crude fibre is practically indigestible, and unless the walls which it forms are broken, comparatively little of the starch is digested and absorbed. In the cooking process, the contents of the cells expand and the walls burst, allowing the contents to come in direct contact with the water, when it is at least partially converted into soluble forms. Thorough cooking of the cereals really consists in rupturing these cell walls and in securing a maximum quantity of starch in a soluble form. The solubility of the protein is generally lessened by cooking, especially at high temperature. Long, slow cooking will soften the crude fibre and change the starch to soluble forms without materially decreasing the solubility of the proteids. Some experiments seem to show that, while the protein is rendered insoluble in the first part of the cooking, long continued action of the heat somewhat changes them into soluble forms.

It is very generally taught that oatmeal and farinas should be cooked six or eight hours before serving. The general practice throughout the country is, however, to cook for a very much shorter period, probably not more than twenty minutes to half an hour. To gather some information reg[illegible]g the extent of the changes affected by the length of time the foods are cooked and to get some data for comparison with the foods sold as ready-to-serve, we cooked oat, wheat, and corn meals for periods of twenty minutes, two hours, five hours, and eight hours, and analyzed a water extract of each, prepared in the same manner as that previously outlined in the study of solubility. The method of procedure was as follows: The meal was stirred into boiling water and the boiling continued vigorously for twenty minutes. A sample of the "porridge" was then taken out for examination and the remainder was placed in a double boiler and the cooking continued for eight hours at a lower temperature. At the two, five, and eight hour periods, a portion of the material was removed and used in determining soluble matter. The percentage soluble was calculated from the dry matter determined in a part of the sample similar to that extracted. No attempt was made to study exhaustively the nature of the changes produced by the cooking, but it was thought that a statement of the amount of soluble matter and the amount of crude dextrin, as stated in Table No. 5, alcohol precipitate, and the amount of sugar, or reducing materials, would give some indication of the nature and the extent of the changes the starch had undergone during the cooking process. The solubility of the proteids was also determined to ascertain what influence the long and short cooking had on these substances. The results form Table No. 5:

TABLE NO. 5: INFLUENCE OF COOKING ON THE SOLUBILITY OF FOODS.

Percentage Composition of Water Extract.

Name of Food.	Time cooked.	Solids.	Alcohol Precipitate. (dextrin.)	Cuprous oxide precipitate. (sugar.)	Soluble Proteids.
Rolled Oats............	Uncooked	8.43	2.36	none	.86*
	20 minutes	14.95	3.36	"	0.89
	2 hours	18.79	4.49	"	1.57
	5 "	29.93	6.92	"	2.28
	8 "	34.30	8.77	"	3.39
Wheat Farina...........	Uncooked	6.97	trace	trace	2.18
	20 minutes	27.40	6.87	"	0.26
	2 hours	37.19	12.8	"	0.42
	5 "	38.37	....	"	0.35
	8 "	39.99	15.1	"	0.65
Cornmeal...............	Uncooked	....	....	....	....
	20 minutes	15.29	11.42	none	0.32
	2 hours	13.78	9.60	"	0.40
	5 "	13.25	10.03	"	0.47
	8 "	20.03	16.84	"	0.60

*No determination made.

The above results indicate very clearly the influence of long cooking on the solubility of the foods. Apparently the wheat farina does not require to be cooked so long as either the cornmeal or the rolled oats, and that the soluble matter in the cornmeal did not increase so rapidly with the longer period of cooking as it did in the other foods. The results of experiments made with rolled oats at the Minnesota Experiment Station* indicate that cooking (four hours) did not increase the solubility of the carbohydrates, and the theory is advanced that the difficulty experienced in digesting imperfectly cooked oatmeal is due to the large amount of mucilaginous proteid material which surrounds the starch grains and prevents their disintegration. It is further argued that when the oatmeal is thoroughly cooked, the protecting action of the proteid substance is overcome and the starch granules are sufficiently broken up to allow the digestive juices to act. The above results with oatmeal show that in our work there was an increase in the solubility of the starch, but that the change towards the dextrin compounds was not sufficient to allow much of it to be thrown down as an alcohol precipitate. There was also an increase in the solubility of the proteid substances. It is certainly evident that the longer periods of cooking increased the amount of soluble matter, and it is quite probable that this would decrease the labor involved in digesting the food.

With the wheat farinas 27.4 per cent. of the total dry matter of the food was soluble in water at the end of twenty minutes, which increased about 10 points when cooked for two hours. As the solubility was only slightly increased at the five and eight hour periods, it would appear as though the longer cooking was not required with this food. More crude dextrin is found in this case and a noticeable difference is observed in the proteid material as compared with the oatmeal. The heat has apparently coagulated, or rendered insoluble, the protein and it has only very slowly changed again under the influence of the longer cooking. The cornmeal, like the farina, under the influence of heat, formed considerable dextrin and the solubility of the proteids was very little changed by the long boiling.

A very interesting point in connection with these experiments is that the amount of soluble matter obtained from the oat, wheat, and corn meals after twenty minutes' cooking was greater than that from some of the so-called cooked foods and even greater than that obtained from some of the much advertised predigested foods; while the longer periods of cooking, especially with the rolled oats and farina, rendered nearly as great an amount of the dry matter soluble as was obtained from the best of the malted and cooked foods. It would certainly appear as though some of these ready-to-serve foods would be the better of further cooking before serving.

DIGESTIBILITY OF BREAKFAST FOODS.

A knowledge of the composition of a food is absolutely necessary in studying, or estimating, its nutritive value. But this is not sufficient, for it is only that part of the food which is actually digested and absorbed that serves to build tissue and carry on the life processes of the animal body. Therefore, to carry on the comparative study of the nutritive value of these foods further we determined the digestibility, or, as Dr. Atwater prefers terming it, the availability of the various food constituents contained in them.

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*Minnesota Experiment Station Bulletin No. 74.

Practical experiments of this nature are surrounded by many difficulties which it is not necessary to fully discuss at this time. Suffice it to say that the necessity of having a large number of results to offset individuality, the separation of the feces, and the arranging of a diet that is simple enough for the purpose of the experiment, and, at the same time, palatable, are among the chief difficulties in procuring reliable results. With reference to the last point, it may be stated that it is seldom possible to have the experiment conducted with the single food under investigation, for the flow of digestive juices is somewhat influenced by the degree with which the food is relished. A special food, such as any of those being studied, if eaten day after day alone, may become so distasteful to the subject of the experiment as to seriously interfere with normal digestion, or even to prevent the completion of the feeding period. On the other hand, while it is necessary to make the diet palatable, it must be simple in order that the digestibility of the specific food under investigation may be calculated. With the foods we studied, the addition of cream and sugar, the digestibility of which are known, was sufficient to make the diet palatable for the full period of the experiment.

In carrying out our digestion experiments, healthy young men of regular habits and taking a fair amount of exercise were used as subjects. They were interested in the experiments and volunteered for the work, and, consequently, willingly co-operated in every way to make the results accurate and the experiments a success. The feeding period in all the experiments was four days, and to offset the question of individuality, each experiment was conducted in triplicate.

Briefly, a general outline of the plan of the experiments is as follows: A definite weight of the food under investigation was cooked; from this each man was allowed to take as much as he wished, an accurate account being kept of the quantity taken, and at the end of the meal the remaining portion was weighed. From the weight of the dry meal taken and its weight when cooked and the weight of the portion eaten, it was possible to calculate the weight of the original meal eaten by each man at each meal, and, consequently, for all the meals throughout the four days of the experiment. Care was taken to have the porridge for each meal cooked alike, the time allowed for this purpose in all experiments, excepting some which will be mentioned later, was 20 minutes from the time the bubbling commenced. Each subject was allowed to use sugar and cream, of known composition, to suit his taste, but an accurate account was kept of the amount consumed. Knowing the composition of the meal, sugar, and cream, and the weight of each used, it was possible to calculate the weight of each constituent consumed. Before the first and after the last meal of the experiment each subject was given a heavy dose of lampblack in capsules. This blackened the feces to such an extent that it was possible to make a fairly accurate separation of that part derived from the food eaten during the experiment. The lag of the lampblack on the wall of the intestine did, in some instances, make the dividing point somewhat indistinct, but in most cases it was quite clearly marked. The feces thus collected were carefully dried, weighed, and analyzed, and the amount of each constituent excreted calculated. Knowing the weight of each constituent eaten and excreted, and assuming that what is not excreted is digested and absorbed, we calculated the percentage digestibility of each constituent.

Strictly speaking, the results thus obtained do not represent actual or true digestibility, because the feces contain, in addition to the portions of the food not digested, some other materials, such as digestive juices and excretory products. On the other hand, these waste materials, or metabolic products, may be considered as representing the cost of digestion in terms of food ingredients. Consequently, while the figures arrived at may be a little below the true digestibility of the foods, they do represent the amount of food available to the body—for what is lost in the metabolic products must be replaced from the food.

The calculation of the amount of energy available to the body is a little more complicated because all the food digested and retained in the system is not fully oxidized. In computing the total fuel value of the food, we figured on the perfectly correct assumption that all the nutrients, excepting ash, may be completely burned. In the body, however, the protein digested is only partially oxidized, as a portion is excreted in the urine as urea, uric acid, etc., compounds capable of further oxidation. Consequently, in computing the amount of energy available to the body, account must be taken of the fuel value of these incompletely oxidized residual products of protein excreted in the urine. This may be done by collecting all the urine for the experimental feeding period and determining the heat of combustion of the organic matter in it. But, in the absence of any means of marking the urine for a given period, similar to that followed in the case of the feces, the only other alternative is to collect the urine throughout the experimental period and determine its fuel value. This may or may not be equal to that which would be formed by the unoxidized nitrogen compounds from the food under investigation. A much simpler method, and the only one open to us, is to calculate the available energy. It has been found in a large number of experiments conducted in Europe and on this continent that the average heat of combustion of the organic matter of the urine corresponding to one gram of digested protein amounts to 1.25 calories.[†] It is generally believed that the energy of the urine calculated by this factor is reasonably accurate. Consequently, the figures representing the per cent. of available energy given in the following tables were obtained by multiplying the total number of grams of digestible protein by the factor 1.25, deducting the amount got in this way from the calories representing the fuel value of the digested portion of the food, dividing this by the number of calories of heat got from the total food and multiplying by 100. This gives the per cent. of the total energy of the food which is available to the body, or the co-efficient of availability of the food.

[†] Storrs Experiment Station Report, 1899, p. 100.

To calculate the digestibility of the breakfast food alone, it is necessary to know the digestibility of the several nutrients contained in the food fed with it. It will be remembered that cream and sugar only were eaten with the cereal. As the digestibility of these has been determined in many experiments, it was assumed that the averages of the results obtained would represent the digestibility of the nutrients in the present experiments. According to these results, 97 per cent. of the protein and 95 per cent. of the fat of cream, and 98 per cent. of the carbohydrates of cream and sugar would be digested;‡ or, in other words, that 3 per cent. of the protein, 5 per cent. of the fat, and 2 per cent. of the carbohydrates would not be digested and should be found in the feces. By use of these factors it is possible to calculate how much of the total feces should be credited to the cream and sugar and how much to the breakfast food experimented with. Having this data, it is an easy matter to figure the percentage digestibility of each of the nutrients of the cereal alone. Reference to the table showing this data reveals the fact that no figures are given for the digestibility of the fat in the breakfast food alone. This is because the amount of fat in the cereal is so small compared with that in the cream that it was thought that any figures obtained would not be reliable.

The data required to compute the available energy of the cereal alone consists of the total fuel value of the cereal, the fuel value of the feces for cereal alone, and the fuel value of the organic matter lost in the urine from the incomplete oxidation of the protein of the cereal. By adding the figures for the last two points together and subtracting the sum from the fuel value of the cereal alone, we have the fuel value, or the available energy, of the cereal alone, and by dividing this by the total fuel value of the cereal and multiplying by 100, we obtain the per cent. of the energy of the cereal available to the body. A full statement of the results of the 46 successfully completed experiments, figured out as above described, furnished a mass of data which it has been found more convenient to place in the appendix. The average results for each food, however, are given in Table No. 6.

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‡Storrs Experiment Station Report, 1899, p. 86.

TABLE No. 6: AVERAGE PERCENTAGE DIGESTIBILITY OF THE DIFFERENT NUTRIENTS AND AVAILABILITY OF ENERGY OF THE TOTAL DIET.

Sample No.	Name of Food.	No. of Expts.	Organic Matter.	Crude Protein.	Crude Fat.	Carbo-hydrates.	Heat of Combustion Available.
	TOTAL DIET.						
14	Granulated Oatmeal.....	3	93.1	77.4	89.5	97.6	90.5
35	Standard Oatmeal.......	3	96.1	89.6	94.6	98.4	93.8
44	Tillson's Pan Dried Oats.	6	94 9	82.9	93.1	98.4	92.6
42	Quaker Oats............	4	94.8	84.0	94.5	98.1	92.4
45	Goldie's Farina.........	5	95.5	79.6	95.4	98.3	93.6
38	Stevens' Breakfast Food..	6	95.2	79.7	95.0	98.1	94.0
36	Wheat Germ	2	96.4	87.9	95.6	98.3	94.4
41	Rolled Wheat...........	3	93.6	79.2	95.6	96.1	93.3
46	Flaked Barley	3	94.8	76.6	95.0	97.7	93.8
47	Flaked Barley	2	94.1	75.9	93.3	97.2	91.7
37	Cornmeal...............	3	96.2	81.8	95.3	98.6	94.8
9	Orange Meat............	2	94.0	81.4	94.9	95.3	92.1
43	Force	2	91.9	69.4	92.7	95.3	90.4
48	Norka..................	2	94.3	83.3	93.7	97.8	91.5
	FOODS ALONE.						
14	Granulated Oatmeal.....	3	91.1	73.5	......	97.5	86.9
35	Standard Oatmeal.......	3	95.5	88.1	......	98.5	92.6
44	Tillson's Pan Dried Oats.	6	94.0	80.2	......	96.8	90.8
42	Quaker Oats	4	94.1	81.3	......	98.1	91.2
45	Goldie's Farina	5	94.6	73.6	......	98.5	92.4
38	Steven's Breakfast Food.	6	94.1	72.1	......	91.8	91.4
36	Wheat Germ	2	96.2	85.9	......	97.9	93.7
41	Rolled Wheat...........	3	91.6	73.3	......	94.8	90.6
46	Flaked Barley	3	93.7	71.3	......	97.6	92.0
47	Flaked Barley	2	92.0	65.8	......	96.8	87.4
37	Cornmeal...............	3	95.8	73.7	......	98.9	94.6
9	Orange Meat............	2	91.7	75.7	......	94.6	90.5
43	Force	2	87.8	59.1	......	94.3	85.9
48	Norka..................	2	93.4	81.0	......	97.6	89.9

The foods used in the investigation, the sample number for reference to Table No. 1, and the number of digestion experiments with each are as follows:

Sample No. 14—Granulated oatmeal.............. 3 digestion experiments.
" " 35—Standard oatmeal.................. 3 " "
" " 44—Tillson's Pan Dried Oatmeal... 6 " "
" " 42—Quaker Oats .... 4 " "
" " 45—Goldie's Farina.................... 5 " "
" " 38—Stevens' Breakfast Food......... 6 " "
" " 36—Wheat Germ .... 2 " "
" " 41—Rolled Wheat...................... 3 " "
" " 46—Flaked Barley .... 3 " "

Sample No.	47—Flaked Barley	2	digestion	experiments.
" "	37—Cornmeal	3	"	"
" "	9—Orange Meat	2	"	"
" "	43—Force	2	"	"
" "	49—Norka	2	"	"

All the foods excepting the last three were prepared by stirring the meal into boiling water and continuing the boiling for twenty minutes. The two samples of rolled oats and the two samples of farinas were also cooked for eight hours and carried through digestion experiments. In the following table the results obtained are averaged with those got from the short cooking period. Later on the results of the short and long cooking periods will be discussed separately. The barley Sample No. 46 is a new food, and is prepared by sprouting the grain, then drying, and flaking. The germination causes the breaking down of insoluble starch, proteids, and even fat into simpler compounds, which are more readily digested. Provided the germination has been allowed to proceed far enough, it would be very natural to suppose that this food would be more easily absorbed. It is being highly recommended as a food for infants and for people with weak digestion.

The above results show that there is no very wide difference in the digestibility of the foods investigated. In all the foods the carbohydrates are the most thoroughly digested and the protein the least. Over 96 per cent. of the organic matter of the total diet in the experiments with standard oatmeal, wheat germ, and cornmeal was digested. The wheat farinas are next in order, with the rolled oats and flaked barleys following closely. Force stands at the bottom of the list with 91.9 per cent. of the total organic matter digested. The differences in the availability of the heat of combustion, or energy, are also comparatively slight, and the foods rank in approximately the same order as in the digestibility of the organic matter.

The second part of the table gives the percentage digestibility of the different nutrients of the foods alone, calculated in the manner described earlier. Here again there is no wide difference in the amount of the various nutrients absorbed by the body and the foods rank in about the same order as when the total diet was considered.

Taking the results as a whole, it is apparent that the nutritive value of the oat, wheat, barley, and corn products is nearly equal. The granulated oatmeal is apparently not as well digested as the standard form. This may be due to the fact that the latter generally contains more of the germ of the grain than the former. The two preparations of rolled oats are practically equal in digestibility and in availability of the energy. This is also true with reference to the farinas, but the wheat germ, which was a good sample and true to name, is of slightly greater value than the farinas, and much superior to the rolled wheat. It is evident that of the two samples flaked barley No. 46, the one that was germinated in its preparation, is slightly the better digested. The carbohydrates of cornmeal were very completely digested, and this food fully sustained its reputation as a good energy producer. Apparently the malting or predigesting to which Orange Meat, Force, and Norka have been submitted in the preparation process has not improved the completeness of their absorption. Even the carbohydrates, which would be the most affected by the previous treatment, are not so completely digested as in the other foods. Of these three foods, or, in fact, of all the foods experimented with, Force has given the poorest results. It will be remembered that in so far as the efficiency of the malting and cooking process can be measured by the solubility of the organic matter of Force, a wheat product, it was not equal to that produced by cooking wheat farinas for twenty minutes; and it is quite possible that this comparatively poor preparation has affected its digestibility.

There is one important factor, namely, ease of digestion, that has not been taken into consideration in the above discussion. All work done in the body must result in the expenditure of a certain amount of energy, and, consequently, while two foods may be equally completely digested, one may be more easily acted upon by the digestive juices, and, as a result, a greater amount of the total energy would be left for the production of new material or for work. We have no way of measuring the energy expended in doing the work of digestion, and, therefore, cannot give figures on this point; but it seems fair to assume that two foods prepared from the same kind of grain and cooked to the same extent, and of practically the same composition, will require an equal amount of energy to carry out the work of digestion. Thus, two samples of rolled oats prepared in the same manner and cooked for the same length of time would probably require an equal amount of energy in digestion. If, however, the preparation of the foods for consumption had increased the solubility of the nutrients of one food more than the other, it would probably be more easily digested. Thus Norka contains, according to our determination, 28 per cent. of soluble matter, while rolled oats, after cooking twenty minutes, contains nearly 15 per cent. But when the cooking process was continued for five hours, the solubility of the oatmeal was equal to that of Norka, and probably the energy of digestion would be about equal. It would be equally correct to argue that as Force contained only 17 per cent. of soluble material and wheat farinas cooked twenty minutes 27 per cent., the former would require a greater expenditure of energy to digest it than the latter. If this be true, then Force not only is less completely digested, as shown in the above table, but it also required the expenditure of more energy to do the work of digestion and thus the nutritive value of the food would be still further decreased.

But while we cannot measure the *ease* with which the digestion of foods is accomplished, we can, to some extent, estimate the *rapidity* of the process. Snyder* has shown that when a definite amount of two lots of oatmeal were cooked for periods of thirty minutes and four hours, respectively, and treated with an equal quantity of malt, 6.1 per cent. of the starch of the oatmeal cooked for the shorter period, and 20.3 per cent. of that cooked for the longer period, was found to be digested at the end of ten minutes. Gudeman,† working along the same lines as Snyder, excepting that he used saliva and pancreatin instead of diastase of malt as the digestion agents, "found that the raw cereals, if sufficiently cooked, were as quickly digested as the best malted cereals, more quickly than prepared (cooked) cereals and a large majority of the so-called malted cereals."

Ease and rapidity of digestion are probably closely associated; for it is natural to assume that if a food is rapidly digested it will be done with the expenditure of less energy than if it required a long time. This is a point of considerable importance, especially to those who are inclined to be dyspeptic. From the data presented, it is evident that the ready-to-serve foods are no more completely digested than the raw foods when properly cooked; and, if we may judge from the percentage amount of soluble matter in the different foods when ready to serve, they are no more easily or rapidly digested.

DIGESTIBILITY OF FOODS, AS INFLUENCED BY SHORT AND LONG PERIODS OF COOKING.

It is quite generally stated that when oat meals, farinas, etc., are cooked for a long time they are made "more digestible." Data has been presented in Table No. 5 which show that the solubility of these foods is increased by the longer periods of cooking. Consequently, as argued above, they would be, as commonly expressed, "more digestible" in the sense of *ease* and *rapidity* of digestion. To ascertain whether this would be accompanied by a greater absorption of the several nutrients, we cooked two samples of rolled oats and two samples of farinas for twenty minutes and for eight hours and carried through digestion experiments in the same manner as previously described. To overcome the influence of individuality in digestion, the same men were used as subjects of the experiments with both methods of cooking, and all the conditions were kept as uniform as possible. The only exception to this was in the case of Sample No. 45, where two men were unable to go on with the second part of the experiment. The results obtained in this work, calculated to percentage, are given in the following table:

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*Minnesota Experiment Station Bulletin No. 74, p. 153.

†Journal American Chemical Society, Vol. 26, p. 321.

Table No. 7 : Average Percentage Digestibility of the Different Nutrients a
Availability of Energy as Influenced by Short and
Long Periods of Cooking.

Sample No.	Name of Food.	No. of digestion expts.	Organic Matter.	Crude Protein.	Crude Fat.	Carbohydrates.	Heat of Combustion.
	Total Diet.						
44	Tillson's Oatmeal :						
	Short cooking	3	94.4	80.4	92.1	98.2	91.9
	Long cooking........	3	95.4	85.3	94.1	98.5	93.2
42	Quaker Oats :						
	Short cooking	1	94.1	82.5	92.8	97.6	89.6
	Long cooking........	3	95.0	84.5	95.1	98.2	93.3
45	Farina :						
	Short cooking	2	96.0	80.7	95.6	98.5	94.2
	Long cooking........	3	95.2	78.8	95.2	98.2	93.4
38	Steven's Breakfast Food :						
	Short cooking	3	95.0	77.9	94.3	98.1	94.1
	Long cooking........	3	95.4	80.3	95.7	98.0	93.8
	Breakfast Food Alone.						
44	Tillson's Oatmeal :						
	Short cooking	3	93.2	77.7	......	98.3	89.8
	Long cooking........	3	94.8	82.6	......	98.7	91.8
42	Quaker Oats :						
	Short cooking	1	93.2	80.9	......	97.6	89.4
	Long cooking.....	3	94.3	81.4	......	98.3	91.7
45	Farina :						
	Short cooking	2	95.7	76.0	......	98.6	93.3
	Long cooking........	3	93.9	70.6	......	98.4	91.5
38	Steven's Breakfast Food :						
	Short cooking	3	93.6	71.3	......	98.1	90.7
	Long cooking........	3	94.6	72.9	......	98.0	92.1

The above results show that the longer period of cooking slightly increased the percentage digestibility of the two samples of rolled oats and the Stevens' Breakfast Food. In every case, with the single exception of the carbohydrates of the last named food, the improvement is noticeable in every constituent of the food examined, as well as in the percentage avaliability of the energy. It is worthy of note that the subjects of the digestion experiments with these foods were the same for the short and long periods of cooking, and, as a different lot of men were used in studying each of the foods, it cannot be said that the results represented the digestibility as determined by one set of men, and it would seem to more fully confirm the deduction that the long cooking slightly increased the digestibility of the food. Unfortunately two of the experiments with short cooking of Quaker Oats were lost. With the farina, only one subject went through both experiments, and two new subjects were brought into the second part of the digestion experiment, thus somewhat destroying the value of the results.

One point worthy of special notice with all the foods is that the long cooking has not increased the percentage digestibility of the carbohydrates materially, and that the chief difference is found in the protein column. This is especially true with the oatmeals. On page 30 it was shown that long cooking increased the solubility of the proteid bodies of these materials, and this has doubtless influenced their digestibility. It will be remembered that twenty minutes' cooking rendered about twice as much of the total solids of wheat meals soluble in water as with the oatmeals. Apparently this has not increased the *completeness* of the digestion of these foods, although it may have rendered them more easily acted upon by the digestive juices.

It is true that the percentage increase in the digestibility of the foods when cooked for the longer period is not very large, and possibly the additional amount of nutrients represented would not be sufficient to warrant the longer cooking; but it must be remembered that the amount of energy required to digest the food will probably be lessened, and the palatability of the food will be improved. In general, it may be argued from the results presented that the longer cooking slightly improved the completeness of digestion, and probably ease of digestion and palatability, making them good nutritious foods, even for those with weak digestion powers. This is especially true of the oatmeals.

PALATABILITY.

Thorough relish for food is without doubt a factor which must be taken into consideration when we come to deal with digestibility. The secretion of the digestive juices which attack the ingested materials is largely under the control of the nervous system, and, therefore, it is reasonable to believe that the enjoyment of eating stimulates the secretory power of the glands which furnish them. No energy or nutritive value is added to a food by reason of its agreeable flavor or tasty appearance, but the amount of it which is finally appropriated by the body for the purpose of nourishment may be greatly increased thereby. It is held by some persons that dyspepsia is often contracted by reason of partaking of food which is not wholly relished, even though it is highly nutritious and well cooked. Palatableness of a food, therefore, determines to a great degree the amount of nutrients which will be extracted from it by the digestive organs. When anticipation alone sometimes "makes the mouth water," the potence of this factor is clearly and practically demonstrated.

These foods are rendered palatable by processes of parching, boiling, malting, and, in some cases, by the addition of other materials. That they are palatable is abundantly evidenced by the fact that they are extensively used; because, no matter how much they are advertised, peop would not continue to use them unless they were palatable. Individu preference for different brands is natural, but this does not imply that t food preferred is more nutritious.

The extensive use of the prepared foods may be taken as an indicati that they "agree" quite generally with those who eat them. Unfortu ately, foods which are really wholesome and nutritious do not agree wi every person, and when they do not their continued use may be harmfu Just why people differ in this respect is not definitely known; nor can an general principle be stated with reference to the matter. Consequentl it is necessary for each person to learn what foods "agree" with the own system. Palatableness and agreeableness of foods usually go t gether, but in some instances they do not.

ECONOMIC VALUE OF FOODS.

So far we have studied and discussed the various kinds of breakfas foods on the basis of chemical composition, energy value, digestibility and palatability. It now remains for us to look into the economic side o the question and see which foods will furnish the largest amount of digest ible matter for the least money. Before presenting the data on this point it may be well to draw attention to the fact that, generally speaking, digested protein from one food is just as valuable as the digested protein of any other food, and the same is true of fat and carbohydrates. Consequently, we have no reason to believe that the digested protein of oatmeal is any more nutritious than that of the various farinas and the numerous kinds of "predigested foods;" or that the latter foods furnish forms of digestible protein, fat, and carbohydrates that are superior to those of any other food. There may be more of the digested nutrients used up in performing the work of digestion in one food than another, but as we cannot measure the amount so used, it is impossible to include it in our calculations relative to economic values. In the following table, the number of grams of digestible protein and carbohydrates, and the number of Calories of heat from ten cents' worth of a number of the foods is given. The calculations were made on the basis of the prices of these foods in Guelph, and on our own determinations of composition and digestibility. In the majority of cases, the weight per package and the weight of food in the package are the average of several weighings. For the sake of comparison, white, entire wheat, and Graham bread are included. These were calculated from data given in Bulletin No. 143 of the Office of Experiment Stations, Department of Agriculture, Washington, D.C.

Table No. 8: Number of Grams of Digestible Protein, Carbohydrates, and Number of Calories from 10 Cents Worth of the Foods.

Food.	How sold.	Price.	Grams of digestible Proteids.	Grams of digestible Carbohydrates.	Calories.
Granulated Oatmeal...	In bulk	7 lbs. for 25c	118.3	885.1	4,922
Rolled Oats..........	"	7 " 25c.	127.1	874.1	4,915
"	In packages	2 " 10c.	90.9	624.1	3,510
Farinas..............	In bulk	6 " 25c.	75.9	806.3	3,860
"	In packages	2 " 15c.	41.8	448.0	2,146
Wheat Germ	In bulk	7 " 25c.	118.9	950.5	4,861
Rolled Wheat.........	"	6 " 25c.	73.9	793.4	3,784
"	In packages	2 lbs. 13 ozs. 15c.	57.8	619.8	2,964
Flaked Barley	In bulk	2 lbs. for 10c.	59.6	683.1	3,035
Cornmeal.............	"	8 " 25c.	70.1	1175.1	5,316
"	In packages	3 " 10c,	62.6	1049.2	4,746
Orange Meat..........	"	20 ozs. for 15c.	26.9	279.3	1,341
Force	"	16 " 15c.	18.0	219.0	1,010
Norka................	"	22 " 15c.	48.5	282.7	1,578
White Bread..........	In loaf	2½ lbs. for 10c.	90.4	546.8	2,817
Entire Wheat Bread...	"	2½ " 10c.	71.5	473.3	2,418
Graham Bread........	"	2½ " 10c.	73.7	443.7	2,322

From the above figures some very interesting conclusions may be drawn. Obviously ten cents' worth of rolled oats, when sold in bulk, will furnish more digestible protein than any other food on the list; granulated oatmeal and wheat germ are practically alike and stand second in order in this respect; while malted or "predigested" foods supply the smallest quantity. In digestible carbohydrates, cornmeal stands first, wheat germ second, and the oatmeals third, with the malted foods again at the foot of the list. In the last column, which gives the energy value of the digestible matter of ten cents' worth of the foods, cornmeal ranks first, furnishing 400 calories of heat more than the oatmeals, which some second in order, and 455 more than wheat germ; while the same amount of money expended on Force will purchase food capable of producing only 1,010 calories of available energy, which is 4,306 less than that of cornmeal.

It may be argued that, as the "predigested" foods are sold in packages, they should be compared with the other foods put up in the same manner. When this is done, the differences in the energy values are not so wide; but, while there is a comparatively narrow margin between such farinas as Cream of Wheat, Meat of Wheat, etc., there is so much more protein and energy obtained from corn and oat meals that they are still very much cheaper. In this connection it is worthy of note that the goods sold in packages are very much more expensive than when sold in bulk. In the case of the farinas, only a litle over half the nourishment would be obtained from the same money expended on package foods as when bought in bulk. In the case of cornmeal the difference is not nearly so wide, but frequently the price of the meal sold in bulk is less than that given, sometimes as much as 10 pounds are given for 25 cents. The foods commonly sold in the package may be cleaner and more conveniently handled, but if they can be procured from a dealer who strives to keep them clean and who is selling sufficiently large quantities to insure a comparatively fresh supply, it is doubtful if very much is gained by purchasing them in this more expensive form.

In justice to the cooked and malted foods, it is only fair to point out that these foods are ready to serve, and, therefore, no expense is incurred in preparing them for the table. It is hardly possible to compute what it would cost under ordinary circumstances to make porridge from the oat or wheat meals; for, in many cases, they are cooked over wood or coal fires and along with the other cooking. Where a special fire is required, the cost of preparing the food will, to some extent, compensate for the difference in the original cost of the goods.

The data presented in the above table seem to clearly show that cornmeal is the most economical heat producer of the cereal foods. If the meal were used unbolted and the germ retained, it would be of even greater value. The oatmeals are nearly equal to the cornmeals in fuel values and contain much more of the proteids, or muscle-forming materials, and more ash, which is so necessary for the formation of bone. The oatmeals are also superior to the farinas, rolled wheat, and flaked barley in protein and carbohydrates and in fuel value. Wheat germ, when it is true to name, is a valuable food. In general, it is true that, while all the breakfast foods are good nutritious materials and that each of these foods have some quality which is specially prized by the individual using it, no breakfast food on the market will furnish so much actual nourishment for so little money as oatmeal. Another point brought out in the last table is that corn, oat, wheat, and barley meals, when sold in bulk and thoroughly cooked, are cheaper sources of digestible nutrients than bread.

SUMMARY.

Although there is such a large number of breakfast foods on the market, they are practically all made from five kinds of cereal grains. The great majority of those used in this country are made from two, oats and wheat, and nearly all of the ready-to-serve type are prepared from one—wheat. The chemical composition of the various foods shows that the method of preparation has not materially altered the proportion of the different nutrients of which they are composed, and that they correspond somewhat closely with the grain from which they were made. The exceptions to this are that in the oat products the amount of crude fibre has been reduced by removing the hull, and that in preparing the finer grades of cornmeal, the bolting process removes a portion of the fat. Whole wheat has about the same amount of crude fibre as the prepared oatmeals, but the farinas have a part of this removed. Many persons consider that, since the bran layers of the wheat contain so much protein and ash material, they should be retained, even if the presence of the associated crude fibre does decrease the digestibility of the food. There would probably be some reason for this contention, especially when fed to young people, if these farinas formed the whole of the diet, but the ordinary mixed diet probably furnishes all the mineral matter which a healthy person requires. Moreover, the presence of crude fibre may injuriously increase peristaltic action, although, for this reason, it may be useful in cases of constipation. The breakfast foods prepared from oats are rich in protein and fat, and those of corn are rich in carbohydrates and poor in protein and fat. Rice is poor in protein and ash and rich in carbohydrates, containing very little crude fibre; while barley contains a fair proportion of all the nutrients, without an undue proportion of crude fibre.

The proportion of the various constituents of the different forms of breakfast foods digested does not differ very widely. Even the so-called "predigested" foods are not more completely digested than the others. What difference there is would go to show that they are not so fully absorbed as the oat and wheat meals when properly cooked.

Thorough cooking is an important factor with starchy foods, and, consequently, with all the foods under discussion. It not only makes the foods more palatable, but it also breaks down the walls of indigestible fibre which surround the starch granules and the other nutrients, and in general produces changes which render the food more susceptible to the action of the digestive juices, thus probably increasing the ease and rapidity of digestion. From the results obtained in our work, it would appear that the farinas do not require so long cooking as the rolled oats or cornmeal. Further, judging by the solubility of the organic matter, some of the much advertised prepared foods are not so well cooked as might be desired; for, while twenty minutes' cooking is not considered sufficient to properly prepare oatmeal porridge, it is found at the end of that time to contain more soluble matter than some of the prepared cooked foods, and nearly as much as some of the cooked and malted preparations. Farinas cooked for the same length of time were, with one exception, about as soluble as all of the so-called "predigested" foods examined. The percentage amount of soluble matter in a food may not form an absolutely correct basis for judging the efficiency of the cooking or malting process; but, as these processes tend to render certain parts of the food soluble, it certainly gives us a good basis of comparison. If this be true, we are right in concluding that some of the prepared foods should be further cooked before serving.

As regards palatability, one food does not seem to have much advantage over another. The mere fact that all are bought and used is sufficient evidence that they are palatable. Certain foods may "agree" with some people better than others. That is, after all, a matter of individuality and each person must choose for himself; but with the great majority of people who use breakfast foods regularly, it is doubtful if the newer "malted" or "predigested" foods are more tasty or palatable than the older-fashioned oat and wheat porridges.

The cost of the numerous kinds of breakfast foods varies widely. The price per package may not be very different, but there is a wide difference in the actual weight of material in the package of the different brands of these foods, and this, together with the differences in composition and digestibility that exist, is sufficient to render the actual nourishment obtained from some foods very much more expensive than others. In many cases the market price has very little connection with the nutritive value, or even with the cost of the materials and preparation. The uncooked oat, wheat, and corn meals, especially those bought in bulk, are the cheapest per pound, both in weight of nutrients purchased and in the amount absorbed by the system. It is possible that the cost of cooking may be sufficient to materially offset this advantage; and that the convenience of the ready-to-serve foods may compensate for the higher cost. These considerations must, of course, vary with circumstances, and each person must decide them for himself.

In general, it may be stated that the various forms of breakfast foods on the market are all wholesome and nutritious foods. At present prices the uncooked oat, wheat, and corn meals are among our most economical sources of nutrients and energy, and, taking everything into consideration, it is probable that oatmeal ranks highest among these. It may not "agree" with everyone, but for those who can use it, there is no breakfast food which combines high protein content and energy producing qualities so well as oatmeal. The reason that prepared breakfast foods are more expensive is evidently not because they contain any more nourishment, but because of the way they are prepared, the manner they are put upon the market, and the cost of advertising. A curious name or appearance or a mysterious process of preparation, does not give them the extraordinary food value sometimes claimed. They may have a place in a hurry-up breakfast, but where economy is considered, there is nothing in the composition, digestibility, or palatability of these high-priced "predigested" foods to justify the extravagant price asked for some of them.

CONCLUSIONS.

1. The various foods agree in composition with the grains from which they are made.

2. The oat products are richest in protein and fat and poorest in carbohydrates; the corn and rice foods are lowest in protein and highest in carbohydrates; while wheat and barley materials stand between the oat and corn products in composition, but more nearly correspond with the former.

3. The ready-to-serve foods contain more soluble matter than the uncooked wheat, oat, and corn meals, but when these latter foods were cooked they were more soluble than some of the former class of foods.

4. The solubility of the ready-to-serve foods varied from 13.7 to 44.2 per cent. of the food, and this soluble part is composed principally of carbohydrates.

5. The oatmeals increased in solubility on cooking, up to eight hours, while with wheat meals, or farinas, no perceptible increase was noticed after two hours, solution being apparently due to insoluble starch being changed into soluble forms.

6. The digestibility of the various constituents of the different types of breakfast foods did not vary widely. Proteids varied most in this respect and were least digested in the ready-to-serve foods.

7. The carbohydrates of the so-called "predigested" foods were no better digested than those of the other foods.

8. The digestibility of oat and wheat meals was but slightly increased by prolonging the cooking from twenty minutes to eight hours, although the longer cooking increased palatability and probably ease of digestion.

9. The corn meals are the cheapest energy producers, but, taking other points into consideration, oatmeals are the most nutritious and economical; while the ready-to-serve foods are the most expensive.

10. Foods purchased in packages are much more expensive than those bought in bulk.

11. The older forms of breakfast foods, especially when sold in bulk, are among our cheapest food.

APPENDIX.

DETAILS OF DIGESTION EXPERIMENTS.

The sample numbers of the breakfast foods experimented with are given in order that the source and composition of the foods may be traced in Table No. 1. The initials of the subjects of the experiments are also given so that the influence of individuality in digestion may be traced.

The results of the digestion experiments are presented in much the same manner as employed by Dr. Atwater in his publication on Experiments on the Digestibility of Cereal Breakfast Foods, in the Sixteenth Annual Report of the Storrs Agricultural Experiment Station, 1904. Three digestion experiments were made with each food, and the detailed results of each experiment and the average co-efficients of digestibility of each food are given in the following tables.

The method of calculating the results have been fully explained in the previous part of the bulletin and need not be repeated here.

TABLES SHOWING DETAILS OF DIGESTION EXPERIMENTS.

Granulated or Pin Head Oatmeal (Sample No. 14).	Total Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Heat of Combus-tion.
Experiment No. 1. Subject: F.A.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—oatmeal	1,280.00	176.82	87.37	992.99	5,927
cream	314.89	28.89	264.00	22.00	2,716
sugar	300.00			300.00	1,230
Total	1,894.89	205.71	351.37	1,314.99	9,873
Feces from total food	180.65	61.29	50.27	43.47	1,007
“ “ cream and sugar		.86	13.20	6.44	154
“ “ oatmeal alone		60.43		37.03	853
Amount digested from total food	1,714.24	144.42	301.10	1.271.52	8,866
“ “ “ oatmeal alone		116.39		955.96	
Energy of urine from total food					181
“ “ “ “ oatmeal alone					145
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	90.5	70.2	85.7	96.6	87.9
“ oatmeal alone	87.4	65.7		96.3	83.2
Experiment No. 2. Subject: W.J.H.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—oatmeal	1,075.50	140.60	69.47	789.46	4,713
cream	314.89	28.89	264.00	22.00	2,716
sugar	300.00			300.00	1,230
Total	1,690.39	169.49	333.47	1,111.46	8,659
Feces from total food	118.92	40.42	34.48	28.57	676
“ “ cream and sugar		.86	13.20	6.44	154
“ “ oatmeal alone		39.56		22.13	522
Amount digested from total food	1,571.47	129.25	298.99	1,082.89	7,983
“ “ “ oatmeal alone		101.04		767.33	
Energy of urine from total food					162
“ “ “ “ oatmeal alone					126
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	92.9	76.3	89.6	97.4	90.3
“ oatmeal alone	90.8	71.9		97.2	86.0
Experiment No. 3. Subject: C.B.T.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—oatmeal	890.50	123.10	60.79	690.80	4,124
cream	314.89	28.89	264.00	22.00	2,716
sugar	300.00			300.00	1,230
Total	1,505.39	151.99	324.79	1,012.80	8,070
Feces from total food	63.02	21.77	20.43	12.90	371
“ “ cream and sugar		.86	13.20	6.44	154
“ “ oatmeal alone		20.91		6.46	217
Amount digested from total food	1,442.37	130.22	304.36	999.90	7,699
“ “ “ oatmeal alone		102.19		684.34	
Energy of urine from total food					163
“ “ “ “ oatmeal alone					128
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.8	85.6	93.3	98.7	93.4
“ oatmeal alone	95.2	83.0		99.1	91.6
Average co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	93.1	77.3	89.5	97.6	90.5
“ oatmeal alone	91.1	73.5		97.5	86.9

TABLES SHOWING DETAILS OF DIGESTION EXPERIMENTS—*Continued.*

Mid Cut or Standard Oatmeal (Sample No. 35).	Total Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Heat of Com-bustion.
Experiment No. 1. Subject: W.J.H.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials— oatmeal.....	953.41	136.10	70.37	728.20	4,443
cream	202.11	21.10	163.00	18.00	1,714
sugar	300.00	....	....	300.00	1,230
Total......	1,455.52	157.21	233.37	1,046.20	7,387
Feces from total food.............	61.43	16.86	14.16	14.93	292
" " cream and sugar	....	.63	8.15	6.36	102
" " oatmeal alone.........	....	16.23	....	8.57	190
Amount digested from total food..	1,394.09	140.35	219.21	1,031.27	7,095
" " " oatmeal alone	....	119.87	....	719.63	....
Energy of urine from total food ...	....	....	....	....	175
" " " " oatmeal alone	....	....	....	....	150
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.8	89.3	93.9	98.6	93.7
" oatmeal alone	95.1	88.1	....	98.8	92.3
Experiment No. 2. Subject: F.A.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—oatmeal.....	1,125.45	160.65	83.07	859.61	5,245
cream	255.01	27.91	203.00	23.80	2,151
sugar.......	300.00	....	....	300.00	1,230
Total......	1,680.46	188.56	286.37	1,183.41	8,626
Feces from total food....	59.20	20.29	15.44	14.58	323
" " cream and sugar......	....	.83	10.15	6.46	121
" " oatmeal alone.........	....	19.46	5.29	8.12	202
Amount digested from total food..	1,621.26	168.27	270.93	1,168.83	8,303
" " " oatmeal alone	....	141.19	....	850.49	....
Energy of urine from total food ...	....	....	....	....	210
" " " oatmeal alone	....	....	....	....	176
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	96.5	89.2	94.6	98.8	93.8
" oatmeal alone	96.2	87.9	....	98.9	92.8
Experiment No. 3. Subject: C.B.T.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—oatmeal.....	673.42	96.12	49.71	514.37	3,137
cream	234.80	25.80	187.00	22.00	1,973
sugar.......	300.00	....	....	300.00	1,230
Total......	1,208.22	121.92	236.71	836.37	6,340
Feces from total food.............	47.72	11.91	10.84	17.87	244
" " cream and sugar......	....	.77	9.85	6.44	118
" " oatmeal alone	....	11.14	....	11.43	126
Amount digested from total food..	1,160.50	110.01	225.89	818.50	6,096
" " oatmeal alone	....	84.98	....	502.94	....
Energy of urine from total food..	....	....	....	....	138
" " " " oatmeal alone	....	....	....	....	106
Co-efficients of digestibility.......	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	96.1	90.2	95.4	97.9	93.9
" oatmeal alone	95.3	88.4	....	97.8	92.7
Average co-efficients of digestibility	per cent	per cent.	per cent.	per cent.	per cent.
Of total food................	96.1	89.6	94.6	98.4	93.8
" oatmeal alone...........	95.5	88.1	....	98.5	92.6

Tables Showing Details of Digestion Experiments—*Continued.*

Short Cooking Tillson's Oatmeal. (Sample No. 44.)	Total Organic Matter.	Protein.	Fat.	Carbohydrates.	Heat of Combustion.
Experiment No. 1. Subject: C.B.T.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—oats	1,270.60	167.67	99.80	979.80	5,935
cream	326.09	28.34	270.75	27.00	2,796
sugar	300.00			300.00	1,230
Total	1,896.69	196.01	370.55	1,306.80	9,961
Feces from total food	120.60	42.74	33.86	24.49	658
" " cream and sugar		.85	13.54	6.54	158
" " oats alone		41.89		17.95	500
Amount digested from total food	1,776.09	153.27	336.69	1,282.31	9,303
" " " oats alone		125.78		961.85	
Energy of urine from total food					192
" " " oats alone					157
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	93.7	78.2	90.9	98.1	91.4
" oats alone	92.1	75.0		98.1	88.8
Experiment No. 2 Subject: K. G.McK.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—oats	1,311.30	173.06	103.00	1,011.80	6,127
cream	331.78	28.90	276.13	27.75	2,852
sugar	300.00			300.00	1,230
Total	1,943 58	201.96	379.13	1,339.55	10.229
Feces from total food	97.00	31.53	26.56	21.66	522
" " cream and sugar		.87	13.80	6.56	161
" " oats alone		30.66		15.10	361
Amount digested from total food	1,846.58	170.43	352.57	1,317.89	9,707
" " " oats alone		142.40		996.70	
Energy of urine from total food					213
" " " oats alone					178
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.1	84.4	93.0	98.4	92.8
" oats alone	94.2	82.3		98.5	91.2
Experiment No. 3. Subject: F.A.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—oats	1,306.80	172.39	102.65	1,007.50	6,102
cream	326.09	28.34	207.75	27.00	2,210
sugar	300.00			300.00	1,230
Total	1,932.89	200.73	373.40	1,334.50	9,542
Feces from total food	115.40	42.73	28.36	24.91	618
" " cream and sugar		.84	10.35	6.54	128
" " oats alone		41.89	18.01	18.37	490
Amount digested from total food	1,817.49	158.00	345.04	1,309.69	8,924
" " " oats alone		130.40	84.64	989.13	
Energy of urine from total food					198
" " " oats alone					163
Co-efficients of digestibility	per cent.	per cent	per cent.	per cent.	per cent.
Of total food	94.3	78.7	92.4	98.1	91.4
" oats alone	93.4	75.7		98.2	89.3
Average Co-efficients of digestibility	per cent	per cent.	per cent.	per cent.	per cent.
Of total food	94.4	80.4	92.1	98.2	91.9
" oats alone	93.2	77.7		98.3	89.8

TABLES SHOWING DETAILS OF DIGESTION EXPERIMENTS—*Continued.*

Long Cooking Tillson's Oatmeal. (Sample No. 44.)	Total Organic Mattér.	Protein.	Fat.	Carbo-hydrates.	Heat of Combustion.
Experiment No. 1. Subject: F.A.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—oats	1,178.00	155.40	92.53	908.41	5,502
cream	373.75	37.25	308.50	28.00	3,204
sugar	300.00	....	....	300.00	1.230
Total	1,851.75	192.65	401 03	1,236.41	9,936
Feces from total food	89.40	32.25	23.62	17.96	484
“ “ cream and sugar	....	1.12	15.42	6.53	174
“ “ oats alone	....	31.13	....	11.40	310
Amount digested from total food	1,762.35	160.40	377.41	1,218.45	9,452
“ “ “ oats alone	....	124.27	....	897.01	....
Energy of urine from total food	....	....	....	....	201
“ “ “ oats alone	....	....	....	....	155
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.7	83.2	94.1	98.5	93.0
“ oats alone	94.4	30.0	....	98.6	91.5
Experiment No. 2. Subject C.B.T.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—oats	1,190.30	157 00	93.51	917.95	5,560
cream	373.75	37.25	308.50	28.00	3,204
sugar	300.00	....	....	300.00	1,230
Total	1,864.05	194.25	402.01	1,245.95	9,994
Feces from total food	87.00	27.28	26.39	18.87	484
“ “ cream and sugar	....	1.12	15.42	6.56	174
“ “ oats alone	....	26.16	....	12 31	310
Amount digested from total food	1,777.05	166.97	375.62	1,227.08	9.510
“ “ “ oats alone	....	130.84	....	905.64	....
Energy of urine from total food	....	....	....	....	209
“ “ “ oats alone	....	....	....	....	164
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.3	85.9	93.4	98.5	93.1
“ oats alone	94.6	83.3	....	98.7	91.5
Experiment No. 3. Subject K. G. McK.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—oats	1,282.40	169.19	101.72	988.80	5,998
cream	373.75	37.25	308.50	28.00	3,204
sugar	300.00	....	....	300.00	1,230
Total	1,956.15	206.44	410.22	1,316.80	10,432
Feces from total food	82.50	27.48	20.73	19.35	434
“ “ cream and sugar	....	1.12	15.42	6.56	174
“ “ oats alone	....	26.36	....	12.79	260
Amount digested of total food	1,873.65	178.96	389.49	1,297.45	9,998
“ “ “ oats alone	....	142.83	....	976.01	....
Energy of urine from total food	....	....	....	....	224
“ “ “ oats alone	....	....	....	....	179
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.3	86.7	94.9	98.5	93.6
“ oats alone	95.3	84.4	....	98.7	92.5
Average Co-efficients of digestibility.	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.4	85 3	94.1	98.5	93.2
“ oats alone	94.8	82.6	....	98.7	91.8

TABLES SHOWING DETAILS OF DIGESTION EXPERIMENTS—*Continued.*

Short Cooking Quaker Oats. (Sample No. 42.)	Total Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Heat of Com-bustion.
Experiment No. 1. Subject: J.B.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—oats	1,896.70	273.36	150.18	1,435.80	9,096
cream	387.96	30.21	330.25	27.50	3,362
sugar	300.00	....	....	300.00	1,230
Total	2,584.66	303.57	480.43	1,763.30	13,688
Feces from total food	152.20	53.02	34.73	40.71	1,113
" " cream and sugar	....	.90	16.50	6.55	427
" " oats alone	....	52.12	....	34.26	686
Amount digested from total food	2,432.46	250.55	445.70	1,722.59	12,575
" " " oats alone	....	221.24	....	1,401.54	....
Energy of urine from total food	....	....	....	....	313
" " " oats alone	....	....	....	....	277
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	94.1	82.5	92.8	97.6	89.6
" oats alone	93.2	80.9	....	97.6	89.4
Experiments Nos. 2 and 3 lost					

TABLES SHOWING DETAILS OF DIGESTION EXPERIMENTS—*Continued.*

Quaker Oats (*Long Cooking,*) (Sample No. 42).	Total Organic Matter.	Protein	Fat.	Carbohydrates.	Heat of Combustion.
Experiment No. 1. Subject: C.L.K.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials: oats	1073.00	154.70	85 00	812.30	5,034
cream	402.67	39.67	333.00	30.00	3,451
sugar	300.00	....	....	300.00	1,230
Total	1,775.67	194.37	418.00	1,142.30	9,715
Feces from total food	69.00	21.56	18.40	16.25	365
" " cream and sugar	....	1.17	16.65	6.60	188
" " oats alone	....	20.39	....	9.65	177
Amount digested from total food	1,706.67	172.81	399.60	1,126.05	9,350
" " " oats alone	....	134.31	....	802.65	....
Energy of urine from total food	....	....	....	....	216
" " " oats alone	....	....	....	....	168
Co-efficients of digestibility:	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	96.1	88.9	95.6	98.6	94.0
" oats alone	96.0	86.8	....	98.7	93.1
Experiment No 2. Subject: J.B.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials: oats	1,307.00	188.50	103.60	989.70	6,133
cream	402.67	39.67	333.00	30.00	3,451
sugar	300.00	....	....	300.00	1,230
Total	2,009.67	228.17	436.60	1,319.70	10,814
Feces from total food	124.80	41.70	29.36	32.70	653
" " cream and sugar	....	1.17	16.65	6.60	188
" " oats alone	....	40.53	....	26.10	465
Amount digested from total food	1,884.87	186.47	407.24	1,287.00	10,161
" " " oats alone	....	147.97	....	963.60	....
Energy of urine from total food	....	....	....	....	233
" " " oats alone	....	....	....	....	185
Co-efficients of digestibility:	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	93.3	81.3	93.3	97.5	91.8
" oats alone	92.3	78.5	....	97.4	89.4
Experiment No. 3. Subject: W. J.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials: oats	855.90	123.90	68.05	650.30	4,030
cream	402.67	39.67	333.00	30.00	3,451
sugar	300.00	....	....	300.00	1,230
Total	1,558.57	163.57	401.05	980.30	8,711
Feces from total food	69.50	27.16	14.97	14.55	359
" " cream and sugar	....	1.17	16.6	6.60	188
" " oats alone	....	25.99	....	7.95	171
Amount digested from total food	1,489.07	136.41	386.08	965.75	8,352
" " " oats alone	....	97.91	....	642.35	....
Energy of urine from total food	....	....	....	....	161
" " " oats alone	....	....	....	....	122
Co-efficients of digestibility:	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.6	83.4	96.3	98.5	94.0
" oats alone	94.7	79.0	....	98.8	92.7
Average co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
of total food	95.0	84.5	95.1	98.2	93.3
" oats alone	94.3	81.4	....	98.3	91.7

TABLES SHOWING DETAILS OF DIGESTIVE EXPERIMENTS—*Continued.*

Farina (*Short Cooking*) (Sample No. 45.)	Total Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Heat of Com-bustion.
Experiment No. 1. Subject, R.J.M	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials: farina	977.58	105.98	14.86	852.10	4,257
cream	353.84	26.09	303.75	24.00	3,077
sugar	300 00			300.00	1,230
Total	1,631.42	132.07	318.61	1,176.10	8,564
Feces from total food	51.60	21.82	12.98	14.09	307
" " cream and sugar		.78	14.97	6.48	172
" " farina alone		21.04		7.61	135
Amount digested from total food	1,579.82	110.25	305.63	1,162.01	8,257
" " " farina alone		84.94		844.49	
Energy of urine from total food					138
" " " farina alone					101
Co-efficients of digestibility:	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	96.8	83.5	95.9	98.8	94.8
" farina alone	97.1	80.1		99.1	94.4
Experiment No. 2. Subject, H.C.W.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials: farina	1,050.10	113.92	15.98	915.70	4,575
cream	388.45	30.22	330.25	28.00	3,364
sugar	300.00			300.00	1,230
Total	1,738.55	144.14	346.23	1,243.70	9,169
Feces from total food	83.30	32.96	16.23	22.77	439
" " cream and sugar		.90	16.51	6.56	186
" " farina alone		32.06		16.21	253
Amount digested from total food	1,655.25	111.18	330.00	1,220.93	8,730
" " " farina alone		81.86		899.49	
Energy of urine from total food					129
" " " farina alone					102
Co-efficients of digestibility:	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.2	77.8	95.3	98.1	93.6
" farina alone	94.3	71.9		98.2	92.2
Experiment No. 3 Subject, G.E.S. Lost.					
Average co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	96.0	80.7	95.6	98.5	94.2
" farina alone	95.7	76.0		98.6	93.3

TABLES SHOWING DETAILS OF DIGESTION EXPERIMENTS—*Continued.*

Farina, long cooking. (Sample No. 45).	Total Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Heat of Combustion.
Experiment No. 1. Subject : C.M.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—farina	740.10	80.26	11.35	645.00	3,224
cream	354.56	38.31	288.25	28.00	3,022
sugar........	300.00	....	....	300.00	1,230
Total......	1,394.66	118.57	299.60	973.00	7,476
Feces from total food.	84.50	28.58	20.87	21.93	453
" cream and sugar......	....	1.15	14.41	6.56	168
" farina alone..........	....	27.43	....	15.37	285
Amount digested from total food..	1,310.16	89.99	278.73	951.07	7,023
" " farina alone	....	52.83	....	629.63	....
Energy of urine from total food ...	....	....	....	....	113
" " farina alone	....	....	....	....	66
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	93.9	75.9	93.0	97.7	92.4
" farina alone..............	91.5	65.8	....	97.6	89.1
Experiment No. 2. Subject : F.M.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—farina	694.46	75.30	10.56	605.30	3,014
cream	354.56	38.31	288.25	28.00	3,022
sugar........	300.00	....	....	300.00	1,230
Total......	1,349.02	113.61	388.81	933.30	7,266
Feces from total food	60.30	25.14	13.09	13.71	326
" cream and sugar.......	....	1.15	14.41	6.56	168
" farina alone..........	....	24.09	....	7.15	158
Amount digested from total food..	1,288.72	88.47	375.72	919.59	6,940
" " farina alone	....	51.21	....	598.15	....
Energy of urine from total food ...	....	....	....	....	111
" " farina alone	....	....	....	....	65
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food................	95.5	77.8	96.6	98.5	93.9
" farina alone	94.5	68.1	....	98.8	92.6
Experiment No. 3. Subject: H.C.W.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—farina	1,019.00	110.46	15.49	887.85	3,850
cream	354.56	38.31	288.25	28.00	3,022
sugar........	300.00	....	....	300.00	1,230
Total......	1,673.56	148.77	303.74	1,215.85	8,102
Feces from total food	66.00	25.60	12.00	18.48	338
" cream and sugar	....	1.15	14.41	6.56	168
" farina alone.........	....	24.45	....	11.92	170
Amount digested from total food..	1,607.56	123.17	291.74	1,197.37	7,764
" " farina alone	....	86.01	....	875.93	....
Energy of urine from total food...	....	....	....	....	154
" " farina alone	....	....	....	....	108
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food................	96.1	82.8	96.0	98.5	93.9
" farina alone	95.7	77.9	....	98.7	92.7
	per cent.	per cent.	per cent.	per cent.	per cent.
Average co-efficients of digestibility	95.2	78.8	95.2	98.2	93.4
Of total food	93.9	70.6	....	98.4	91.5
" farina alone					

TABLES SHOWING DETAILS OF DIGESTION EXPERIMENTS—*Continued.*

Steven's Breakfast Food, short cooking. (Sample No. 38).	Totol Organic Matter.	Protein.	Fat.	Carbohydrates.	Heat of Combustion.
Experiment No. 1. Subject: W.J.H.	Gms.	Gms.	Gms.	Gms.	Gms.
Food materials—farina........	937.70	96.27	11.54	824.30	4,055
cream	353.84	26.09	303.75	24.00	3,077
sugar	300.00	....	....	300.00	1,230
Total......	1,591.54	122.36	315.29	1,148.30	8,362
Feces from total food.	56.60	21.82	12.98	14.09	307
" cream and sugar	....	.73	15.19	6.48	172
" farina alone..........	....	21.04	....	7.61	135
Amount digested from total food..	1,534.94	100.54	302.31	1,134.21	8,055
" " farina alone	....	75.23	....	816.69	....
Energy of urine from total food ..	....	....	....	....	126
" " farina alone	....	....	....	....	94
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food............	96.4	82.2	95.9	98.8	94.8
" farina alone	96.4	78.1	....	99.0	94.3
Experiment No. 2. Subject: J.D.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—farina	971.10	99.70	11.96	853.66	4,200
cream	401.89	32.64	340.25	29.00	3,369
sugar........	300.00	....	....	300.00	1,230
Total......	1,672.99	132.34	352.20	1,182.66	8,799
Feces from total food	80.00	25.68	21.02	20.87	433
" cream and sugar.......	....	98.00	17.03	6.58	191
" farina alone	....	24.70	....	14.29	242
Amount digested from total food ..	1,592.99	106.66	331.18	1,161.79	8,366
" " farina alone	....	75.00	....	839.37	....
Energy of urine from total food ...	....	....	....	....	133
" " farina alone	....	....	....	....	94
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.2	80.6	94.0	98.2	93.5
" farina alone	94.3	75.2	....	98.3	92.0
Experiment No. 3. Subject: M.F.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—farina	752.30	77.24	9.26	661.40	3,051
cream	388.47	30.22	230.25	28.00	2,434
sugar........	300.00	....	....	300.00	1,230
Total......	1,440.77	107.46	339.51	989.40	6,715
Feces from total food............	93.10	31.26	24.26	25.78	516
" cream and sugar	....	.90	11.51	6.56	139
" farina alone	....	30.36	....	19.22	377
Amount digested from total food..	1,347.67	76.20	315.25	963.62	6,199
" " farina alone	....	46.88	....	642.18	....
Energy of urine from total food ...	....	....	....	....	95
" " farina alone	....	....	....	....	59
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	93.5	70.9	92.9	97.4	94.0
" farina alone	90.1	60.7	....	97.1	85.7
Average co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.0	77.9	94.3	98.1	94.1
" farina alone	93.6	71.3	....	98.1	90.7

Tables Showing Details of Digestion Experiments—*Continued.*

Steven's Breakfast Food, long cooking. (Sample No. 38).	Total Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Heat of Com-bustion.
Experiment No. 1. Subject: J.D.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—farina	775.12	79.58	9.54	681.40	3,352
cream	265.77	30.72	213.05	22.00	2,252
sugar	300.00			300.00	1,230
Total	1,340.89	110.30	222.59	1,003.40	6,854
Feces from total food	65.40	20.22	9.64	26 34	317
" cream and sugar		.91	10.65	6.44	131
" farina alone		19.31		19.90	186
Amount digested from total food	1,275.49	90.08	212.95	977.06	6,517
" " farina		60.27		661.50	
Energy of urine from total food					113
" " farina					75
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.1	81.7	95.7	97.4	93.7
" farina alone	93.8	73.2		97.1	92.2
Experiment No. 2. Subject: F.M.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—farina	784.00	80.50	9.65	689.22	3,391
cream	354.56	38.31	288.25	28.00	3,022
sugar	300.00			300.00	1,230
Total	1,438.56	118.81	297.90	1,017 22	7,643
Feces from total food	47.00	19.72	5.56	23.56	265
" cream and sugar		1.15	14.41	6.56	168
" farina alone		18.57		7.00	97
Amount digested from total food	1,391.56	99.09	292.34	1,003.66	7,419
" " farina		61.93		682.22	
Energy of urine from total food					124
" " farina					77
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	96.7	83.4	98.1	98.6	95.4
" farina alone	96.7	76.9		98.9	94.8
	Gms.	Gms.	Gms.	Gms.	Gms.
Experiment No. 3. Subject: W.J H.					
Food materials—farina	1,059.20	108.70	13.03	930.84	4,002
cream	354.56	38.31	288.25	28.00	3,022
sugar	300.00			300.00	1,230
Total	1,713.76	147.01	301.28	1,258.84	8,254
Feces from total food	94.00	35.43	20.50	24.67	501
" cream and sugar		1.15	14.41	6.56	168
" farina alone		34.28		18.11	333
Amount digested from total food	1,619.76	111.58	280.78	1,234.17	7,753
" " farina		74.42		912.73	
Energy of urine from total food					140
" " farina					93
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	94.5	75.9	93.2	98.0	92.2
" farina alone	93.2	68.5		98.0	89.4
Average co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.4	80 3	95.7	98.0	94.0
" farina alone	94.6	72.9		98 0	92.1

TABLES SHOWING DETAILS OF DIGESTION EXPERIMENTS—*Continued.*

Goldie's Wheat Germ. (Sample No. 36.)	Total Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Heat of Combustion.
	Gms.	Gms.	Gms.	Gms.	Cals.
Experiment No. 1. Subject: W.J.H.					
Food Materials—wheat germ..	907.59	108.40	27.58	758.80	4,007
cream	253.75	26.25	199.50	28 00	2,128
sugar	300.00	....	....	300.00	1,230
Total......	1,461.34	134.65	227.08	1,086.80	7,365
Feces from total food.............	58.42	19.20	10.87	20.00	296
" cream and sugar	....	.75	9.97	6.56	124
" wheat germ alone......	....	18.42	....	13.44	172
Amount digested from total food..	1,402.92	115.45	216.21	1,066.80	7,069
" " germ alone ...	....	89.98	....	745.36	....
Energy of urine from total food ...	....	....	....	....	144
" " germ alone .	....	....	....	....	112
Coefficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food.................	96.0	85.7	95.2	98.1	94.0
" wheat germ alone..........	95.5	83.0	....	98.2	92.9
Experiment No. 2. Subject: F.A.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—germ	1,164.07	139.40	35.45	975.40	5,151
cream	253.75	26.25	199.50	28.00	2,128
sugar........	300.00	....	....	300.00	1,230
Total......	1,717.82	165.65	234.95	1,303.49	8,509
Feces from total food.............	54.12	16.50	8.47	19.40	256
" cream and sugar.......	....	.78	9.97	6.56	124
" germ alone............	....	15.72	....	12.93	132
Amount digested from total food..	1,663 70	149.15	225.48	1,284.00	8,253
" " germ alone ...	....	123.68	....	952.47	....
Energy of urine from total food ...	....	....	....	....	186
" " germ alone..	....	....	....	....	154
Coefficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food..................	96.8	90.0	95.9	98.5	94.8
" wheat germ alone	96.8	88.7	....	97 6	94.5
Experiment No. 3. Subject: C.B.T. Lost.					
Average coefficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food.................	96.4	87.9	95.6	98.3	94.4
" wheat germ alone.........	96.2	85.9	....	97.6	93.7

Tables Showing Details of Digestion Experiments—*Continued.*

Rolled Wheat. (Sample No. 41.)	Total Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Heat of Combustion.
Experiment No. 1. Subject: F.A.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—wheat	897.11	86.75	18.44	774.30	3,858
cream	387.87	21.87	338.00	28.00	3,387
sugar	300.00	....	....	300.00	1,230
Total	1,584.98	108.62	356.44	1,102.30	8,475
Feces from total food	109.57	25.36	18.87	47.92	522
" " cream and sugar	....	.65	16.90	6.56	188
" " wheat alone	....	24.71	....	40.36	334
Amount digested from total food	1,475.41	83.26	337.57	1,054.38	7,953
" " " wheat alone	....	62.04	....	733.94	....
Energy of urine from total food	....	....	....	....	104
" " " wheat alone	....	....	....	....	78
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	93.1	76.6	94.7	95.6	92.6
" wheat alone	90.4	71.5	....	94.8	89.3
Experiment No. 2. Subject: W.J.H.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—wheat	803.40	77.69	16.51	693.40	3,455
cream	387.87	21.87	338.00	28.00	3,387
sugar	300.00	....	....	300.00	1,230
Total	1,491.27	99.56	354.51	1,021.40	8,072
Feces from total food	85.61	20.09	17.24	40.08	443
" " cream and sugar	....	.65	16.90	6.56	188
" " wheat alone	....	19.44	....	33.52	255
Amount digested from total food	1,405.66	79.47	337.27	981.32	7,629
" " " wheat alone	....	58.25	....	659.88	....
Energy of urine from total food	....	....	....	....	99
" " " wheat alone	....	....	....	....	73
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	93.6	79.8	95.1	96.0	93.3
" wheat alone	92.3	77.7	....	95.1	90.4
Experiment No. 3. Subject. C.B.T.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—wheat	696.80	67.40	14.32	601.54	2,997
cream	387.87	21.87	338.00	28.00	3,387
sugar	300.00	....	....	300.00	1,230
Total	1,384.67	89.27	352.32	929.54	7,614
Feces from total food	79.41	16.83	10.42	38.93	356
" " cream and sugar	....	.65	16.90	6.56	188
" " wheat alone	....	16.18	....	32.37	168
Amount digested from total food	1,305.26	72.44	341.90	890.61	7,258
" " " wheat alone	....	51.22	....	569.17	....
Energy of urine from total food	....	....	....	....	91
" " " wheat alone	....	....	....	....	64
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	94.2	81.1	97.0	96.8	94.1
" wheat alone	92.1	70.6	....	94.6	92.2
Average Co-efficients of digestibility	p r cent.	per cent.	per cent.	per cent.	per cent.
Of total food	93.6	79.2	95.6	96.1	93.3
" wheat alone	91.6	73.8	....	94.8	90.6

TABLES SHOWING DETAILS OF DIGESTION EXPERIMENTS—*Continued.*

Flaked Barley. (Sample No. 46.)	Total Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Heat of Com-bustion.
Experiment No. 1. Subject: F.A.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—barley	812.45	96.06	10.95	695.50	3,520
cream	460.01	23.01	413.00	24.00	4,075
sugar	300.00	....	....	300.00	1,230
Total	1,572.46	119.07	423.95	1,019.50	8,825
Feces from total food............	94.25	31.55	19.11	27.97	479
“ “ cream and sugar.......	... .	.69	20.65	6.48	222
“ “ barley alone.	....	30.86	....	21.49	257
Amount digested from total food ..	1,478.21	87.52	404.84	981.53	8,346
“ “ “ barley alone	....	65.20	....	674.01	. .....
Energy of urine from total food...	....	....	....	....	109
“ “ “ barley alone.	....	....	....	....	39
Co-efficients of digestibility.......	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food................	94.0	73.5	95.5	97.3	93.3
“ barley alone	91.8	67.8	....	97 0	91.5
Experiment No. 2. Subject: W.J.H.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—barley.......	799.70	94.57	10.77	684.59	3,565
cream	460.01	23.01	413.00	24.00	4,075
sugar........	300.00	....	....	300.00	1,230
Total	1,559.71	117.58	423.77	1,008.59	8,870
Feces from total food............	64.06	22.49	14.06	17.83	335
“ “ cream and sugar.......	....	.69	20.65	6.48	222
“ “ barley alone	....	21.80	....	11.35	113
Amount digested from total food..	1,495.65	95.09	409.71	990.76	8,535
“ “ “ barley alone	....	72.77	....	673.24	....
Energy of urine from total food...	....	....	....	....	119
“ “ “ barley alone	....	....	....	....	91
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food................	95.9	80.9	96.7	98.2	94.9
“ barley alone..............	95.4	76.9	....	98.4	94.2
Experiment No. 3. Subject: C.B.T.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—barley.......	689.86	81.65	9.29	590.54	2,989
cream	460.01	23.01	413 00	24.00	4,075
sugar........	300.00	.. ..	....	300.00	1,230
Total	1,449.87	104.66	422.29	914.54	8,294
Feces from total food............	79.94	25.72	20.33	22.20	429
“ “ cream and sugar.	....	.69	20.65	6.48	222
“ “ barley alone	....	25.03	....	15.36	207
Amount digested from total food..	1,369.93	78.94	401.96	892.34	7,835
“ “ “ barley alone	....	56.62	....	575.18	....
Energy of urine from total food...	....	....	....	....	99
“ “ “ barley alone.	....	....	....	....	71
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food................	94.5	75.4	95.2	97.6	93.3
“ barley alone..............	93.9	69 3	....	97.3	90.4
Average Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food................	94.8	76.6	95.8	97.7	93.8
“ barley alone..............	93.7	71.3	....	97.6	92.0

Tables Showing Details of Digestion Experiments.—*Continued.*

Flaked Barley. (Sample No. 47.)	Total Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Heat of Combustion.
Experiment No. 1. Subject: C.B.T.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—barley	669.40	52.28	9.20	587.85	2,804
cream	286.43	30.43	232.00	24.00	2,436
sugar	300.00	....	....	300.00	1,230
Total	1,255.83	82.71	241.20	911.85	6,470
Feces from total food	79.64	23.09	15.71	28.26	399
" " cream and sugar	....	.91	11.6	6.48	43
" " barley alone	....	22.18	....	21.78	356
Amount digested from total food	1,176.19	59.62	225.49	883.59	6,071
" " " barley alone	....	30.10	5.09	566.07	....
Energy of urine from total food	....	....	....	....	75
" " " barley alone	....	....	....	....	37
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	93.7	72.1	93.5	96.9	90.2
" barley alone	90.9	57.6	....	96.3	85.9
Experiment No. 2. Subject: F.A.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—barley	947.60	93.17	13.03	832.12	4,083
cream	286.43	30.43	232.00	24.00	2,436
sugar	300.00	....	....	300.00	1,230
Total	1,534.03	123.60	245.03	1,156.12	7,749
Feces from total food	84.34	25.10	16.89	29.59	426
" " cream and sugar	....	.91	11.60	6.48	43
" " barley alone	....	24.09	....	23.11	383
Amount digested from total food	1,449 69	98.50	228.14	1,126.53	7,323
" " " barley alone	....	69.08	7.74	809.01	....
Energy of urine from total food	....	....	....	....	101
" " " barley alone	....	....	....	....	71
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	94.5	79.7	93.1	97.4	93.2
" barley alone	93.1	74.0	....	97 2	88.8
Experiment No. 3. Subject: W.J.H.—Lost.					
Average co-efficients of digestibility.	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	94.1	75.9	93.3	87.2	91.7
" barley alone	92.0	65.8	....	96.8	87.4

Tables Showing Details of Digestion Experiments—*Continued.*

Cornmeal. (Sample No. 37.)	Total Organic Matter.	Protein.	Fat.	Carbohydrates.	Heat of Combustion.
Experiment No. 1. Subject: K.G.Mc.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—cornmeal	987.80	75.00	7.08	902.50	3,810
cream	315.30	38.60	248.70	28.00	2,655
sugar	300.00			300.00	1,230
Total	1,603.10	113.60	255.78	1,230.50	7,695
Feces from total food	51.25	19.91	9.41	13.39	250
“ “ cream and sugar		1.16	12.44	6.56	152
“ “ cornmeal alone		18.75		6.83	98
Amount digested from total food	1,551.85	93.69	246.37	1,217.11	7,445
“ “ “ cornmeal		56.25		895.67	
Energy of urine from total food					117
“ “ “ cornmeal					70
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	96.8	82.5	96.3	98.9	95.2
“ cornmeal alone	96.8	75.0		99.2	95.5
Experiment No 2. Subject: JE.B.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—cornmeal	958.20	72.76	6.88	875.50	4,083
cream	315.30	38.60	248.70	28.00	2,655
sugar	300.00			300.00	1,230
Total	1,573.50	111.36	255.58	1,203.50	7,968
Feces from total food	60.36	19.87	14.39	14.38	310
“ “ cream and sugar		1.16	12.44	6.56	152
“ “ cornmeal alone		18.71		7.82	158
Amount digested from total food	1,513.14	91.49	241.19	1,189.12	7,658
“ “ “ barley		54.05		868.94	
Energy of urine from total food					114
“ “ “ barley					68
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	96.2	82.2	94.4	98.8	94.7
“ cornmeal alone	95.8	74.3		99.1	94.4
Experiment No 3. Subject: C.R.K.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—cornmeal	908.81	69.01	6.53	830.40	3,872
cream	287.60	36.30	225.30	26.00	2,416
sugar	300.00			300.00	1,230
Total	1,496.41	105.31	231.83	1,156.40	7,518
Feces from total food	63.62	20.44	11.22	20.77	310
“ “ cream and sugar		1.09	11.26	6.42	138
“ “ cornmeal alone		19.35		14.35	172
Amount digested from total food	1,432.79	84.87	220.61	1,135.63	7,208
“ “ “ cornmeal		49.66		816.05	
Energy of urine from total food					106
“ “ “ cornmeal					62
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	95.7	80.6	95.2	98.2	94.5
“ cornmeal alone	94.9	71.9		98.3	93.9
Average co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	96.2	81.8	95.3	98.6	94.8
“ cornmeal alone	95.8	73.7		98.9	94.6

TABLES SHOWING DETAILS OF DIGESTION EXPERIMENTS—*Continued.*

Orange Meat. (Sample No. 9.)	Total Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Heat of Com-bustion.
Experiment No. 1. Subject: F.A.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—orange meat	1,272.95	120.30	15.56	1,109.25	5,402
cream	293.13	40.78	224.35	28.00	2,445
sugar	300.00	....	....	300.00	1,230
Total	1,866.08	161.08	239.91	1,437.25	9,077
Feces from total food	132.42	32.01	14.55	68.68	606
" " cream and sugar	....	1.22	11.21	6.56	138
" " orange meat alone	....	30.79	....	62.12	468
Amount digested from total food	1,733.66	129.07	225.36	1,368.51	8,471
" " " orange meat	....	89.51	....	1,047.13	....
Energy of urine from total food	....	....	....	....	161
" " " orange meat	....	....	....	....	112
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	94.0	80.1	93.9	95.2	91.5
" orange meat alone	91.1	74.4	....	94.4	90.0
Experiment No. 2. Subject: W.J.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—orange meat.	993.75	93.91	12.15	865.88	4,217
cream	265.68	38.18	201.60	26.00	2,206
sugar	300.00	....	....	300.00	1,230
Total	1,559.43	132.09	213.75	1,191.88	7,653
Feces from total food	95.06	22.80	8.62	50.40	421
" " cream and sugar	....	1.15	10.08	6.52	127
" " orange meat alone	....	21.65	....	43.88	294
Amount digested from total food	1,464.37	109.29	205.13	1,141.48	7,232
" " " orange meat	....	72.26	....	822.00	....
Energy of urine from total food	....	....	....	....	137
" " " orange meat.	....	....	....	....	90
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	93.9	82.7	95.9	95.3	92.7
" orange meat alone	92.2	76.9	....	94.8	90.9
Average co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	94.0	81.4	94.9	95.2	92.1
" orange meat alone	91.6	75.7	....	94.6	90.5

Force. [Sample No. 43.]	Total Organic Matter.	Protein.	Fat.	Carbo-hydrates.	Heat of combus-tion.
Experiment No. 1. Subject: M.F.C.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—force	814.10	86.22	18.72	688.18	3,502
cream	355.83	39.33	308.50	28.00	3,215
sugar	300.00	....	....	300.00	1,230
Total	1,469.93	125.55	327.22	1,016.18	7,947
Feces from total food	96.98	28.52	19.69	33.59	489
" cream and sugar	....	1.18	15.42	6.56	177
" force alone	....	27.34	....	27.03	312
Amount digested from total food	1,372.95	97.03	307.53	982.59	7,458
" " force alone	....	58.88	....	661.15	....
Energy of urine from total food	....	....	....	....	121
" " force alone	....	....	....	....	74
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	94.8	77.3	93.9	96.7	92.3
" force alone	90.9	68.2	....	96.1	88.9
Experiment No 2. Subject: C. M.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—force	1,161.95	123.10	26.72	982.35	5,002
cream	355.83	39.33	308.50	28.00	3,215
sugar	300.00	....	....	300.00	1,230
Total	1,817.78	162.43	335.22	1,310.35	9,447
Feces from total food	200.45	62.65	28.33	79.48	959
" cream and sugar	....	1.18	15.42	6.56	177
" force alone	....	61.47	....	72.99	782
Amount digested from total food	1,617.33	99.78	306.89	1,230.87	8,488
" " force alone	....	61.63	....	909.43	....
Energy of urine from total food	....	....	....	....	124
" " force alone	....	....	....	....	77
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	88.9	61.4	91.5	93.9	88.5
" force alone	84.7	50.0	....	92.5	82.8
Average co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food	91.9	69.4	92.7	95.3	90.4
" force alone	87.8	59.1	....	94.3	85.9

Tables Showing Details of Digestion Experiments—*Concluded*.

Norka. [Sample No. 48.]	Total Organic Matter.	Protein.	Fat.	Carbohydrates.	Heat of Combustion.
Experiment No. 1. Subject: K.G.Mc.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—Norka.........	1,639.85	239.50	85.24	1,262.25	7,481
cream.........	293.13	40.78	224.35	28.00	2,445
sugar..........	300.00	....	....	300.00	1,230
Total......	2,232.98	280.28	309.59	1,590.25	11,156
Feces from total food.............	149.75	54.98	25.56	45.04	747
" cream and sugar.......	....	1.22	11.21	6.56	138
" Norka alone..........	....	53.76	....	38.48	609
Amount digested from total food..	2,083.23	225.30	284.03	1,545.21	10,409
" " Norka alone	....	185.74	....	1,223.77	....
Energy of urine from total food...	....	....	....	....	282
" " Norka alone.	....	....	....	....	232
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food.................	93.3	80.4	91.7	97.2	90.8
" Norka alone..............	92.0	77.6	....	96.9	88.8
Experiment No. 2. Subject: C.B.T.	Gms.	Gms.	Gms.	Gms.	Cals.
Food materials—Norka.........	1,679.00	245.25	87.30	1,292.75	7,559
cream.........	293.13	40.78	224.35	28.00	2,445
sugar..........	300.00	....	....	300.00	1,230
Total......	2,272.13	286.03	311.65	1,620.75	11,234
Feces from total food.............	106.00	39.39	23.41	27.59	563
" cream and sugar.......	....	1.22	11.21	6.56	138
" Norka lone...........	....	38.17	....	21.03	425
Amount digested from total food..	2,166.13	246.64	288.24	1,593.16	10,671
" " Norka alone	....	207.08	....	1,271.72	....
Energy of urine from total food...	....	....	....	....	308
" " Norka alone.	....	....	....	....	259
Co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food.................	95.3	86.2	95.7	98.3	92.2
" Norka alone..............	94.7	84.4	....	98.3	90.9
Average co-efficients of digestibility	per cent.	per cent.	per cent.	per cent.	per cent.
Of total food.................	94.3	83.3	93.7	97.7	91.5
" Norka alone..............	93.3	81.0	....	97.6	89.9

INDEX.

Page.
Introduction 1
The importance of cereal grains in our diet 1
Outline of work done elsewhere 2
The nature of breakfast foods on the market 2
Composition of breakfast foods 5
Influence of special process of manufacture on solubility of foods.... 13
Influence of cooking on solubility of foods 18
Digestibility of breakfast foods 20
Digestibility of breakfast foods, as influenced by short and long periods of cooking 27
Palatability 29
Economic value of foods 30
Summary 32
Conclusions 34
Appendix 37